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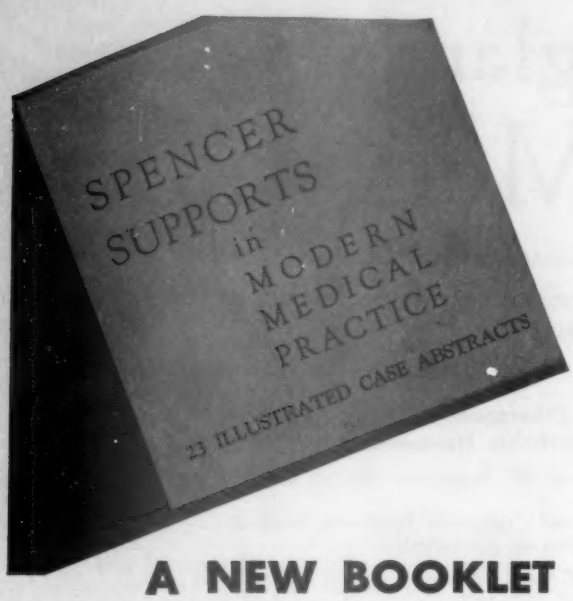


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# THE EFFECT OF INJURY TO THE SPINAL CORD AND CAUDA EQUINA ON THE SEXUAL POTENCY OF MEN*

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PATIENTS who are paralyzed as the result of an injury to the spinal cord or cauda equina have to face many difficult physical and psychologic problems. One of the most difficult of the psychologic ones is that which has to do with their loss of sexual ability. To discuss it at all with their doctors requires mutual understanding and confidence. Such confidence presupposes knowledge on the part of the physicians — that is, knowledge of the effect of a cord injury on the various aspects of sexual and possibly married life. Unfortunately, such basic information is conspicuous by its absence. Doctors, therefore, either admit their ignorance or make up explanations and prognoses out of whole cloth.

Because of the confusion between what has been demonstrated in animals and deduced in man, all sorts of legends about the effect of spinal-cord injuries on the sexual act in man have come to be accepted. One hears, for example, that lesions of the conus will cause impotence; that transection at any level of the cord will always have the same effect; and that priapism has prognostic significance and the like. Impotence has not been distinguished from sterility, and this medical ignorance has become a matter of concern to prospective spouses. The fact appears to be that as far as we can find out, except as noted below, competent physiologic study of the effect on the sexual capacity of man of partial and transverse injuries of the spinal cord, as well as injuries of varying degree to the cauda, has not been made.

The concentration of paralytic patients with cord injuries at certain veterans' hospital centers offered a unique opportunity to study this aspect of the sterility problem in men provided that the patients would co-operate. Such co-operation was forthcoming at Cushing Veterans Administration Hospital at Framingham, Massachusetts. This paper is a report of an investigation on the relation between spinal-cord and cauda-equina injuries and sexual potency that has been carried out on these volunteers. A paper on sterility will follow.

## NEUROANATOMY AND PHYSIOLOGY

Despite the traditions and misinterpretations that have sprung up over the years the description of the neuroanatomy and neurophysiology of the activities of the generative apparatus as given by Starling[1] and Sherrington[2] are the basis of all later work. So far as the male is concerned they point out that in animals the sexual reflexes of erection and ejaculation are independent of suprasegmental connections. Erection takes place reflexly as the result of the active dilatation of the vessels of the penis and contraction of the ischiocavernosus muscle, with resultant compression of the dorsal veins of the penis. The vasa deferentia and the seminal vesicles in the cat, for example, are described as being supplied by the sympathetic nerves via the inferior mesenteric and hypogastric plexuses. Starling[1] says that "stimulation of these nerves excites strong contraction of the whole musculature of the vasa deferentia and seminal vesicles, which may be strong enough to cause emission of semen from the penis." The sympathetic system is not the only source of neural impulses, however, because the ischiocavernosus and bulbocavernosus and constrictor urethrae muscles, which not only are involved in the erection of the penis but also assist in the emission of the semen, are supplied by somatic neurones through the internal pudic nerves. The bladder is supplied through the parasympathetic system. They give the origin of these various connections as being in the lumbar and sacral portions of the cord.

So far as man is concerned, Woolsey[3] says no more than that "Priapism is common in high (cord) lesions especially when severe." Frazier and Allen[4] have no comments on this subject. Head and Riddoch[5] also have nothing to say about this aspect

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The conclusions and opinions expressed herein are the authors' own and do not necessarily represent those of the Veterans Administration or the United States Army.

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of cord injuries, nor does Wilson.[6] Grinker[7] makes the statement that "fracture (of the first lumbar vertebra) [*sic*] produces loss of sexual function." Fulton[8] follows Sherrington, and Cobb and Coleman[9] deal with the return of sexual function in patients that recovered from spinal-cord injuries only from the point of view of time. Kuntz[10] writes that in man the testicles, seminal vesicles, vasa deferentia and epididymis all receive their innervation from the sympathetic system. The prostate and prostatic urethra, as well as the corpora cavernosa penis, are innervated by both the sympathetic and the parasympathetic and the corpora cavernosa urethrae and the penile urethra through the communications with the internal pudic nerves in addition. He also notes that the voluntary muscles employed in the act of ejaculation — that is the compressor urethrae and ischiocavernosus and bulbocavernosus muscles — are supplied through the branches of the internal pudic nerves. The preganglionic and visceral afferent sympathetic fibers are described as components of the tenth and higher thoracic (up to the sixth) nerves. The parasympathetic and internal pudic central connections are said to be through the second, third and fourth sacral segments. Kuntz states further:

> Our knowledge of the role of nerve impulses in the regulatory control of the functions of the male sex organs is based mainly on the findings of the early physiologists. The results of animal experimentation however . . . clearly indicate that reflex erection is mediated through centers in the lumbar and sacral segments of the spinal cord and another in the lumbar cord which mediates reflex ejaculation.

In general, his conclusions are in agreement with those of Starling and Sherrington cited above, but he leaves the impression that he predicates an ejaculatory center in the lumbar portion of the cord in man. He does note however, that "In man voluntary inhibition also plays an important role in sexual excitability and under normal conditions is the controlling factor in sexual behavior."

White and Smithwick[11] quote Kuntz and the older physiologists but in addition point out that Simeone[12] demonstrated in man that if those sympathetic nerves which, when stimulated, cause contraction of the vasa deferentia and the seminal vesicles were paralyzed viable spermatozoa no longer reached the seminal vesicles. They also quote Learmonth[13] to the effect that after removal of the superior hypogastric plexus or injury to the first lumbar ganglions the power of ejaculation is lost although the operation does not impair the power of erection or the sensation of orgasm. Thus, an abdominal sympathectomy would produce this result. They state that in man the central site of the parasympathetic neuron cells is in the anterior horns of the second, third and fourth sacral segments and that the sympathetic preganglionic cells lie in the lower thoracic and upper lumbar levels of the intermediolateral column. The somatic connections are through the anterior horns and the posterior and lateral columns of the second, third and fourth sacral segments.

It may be concluded from this evidence that in animals the act of erection is reflex and accomplished by engorgement of vessels of the penis aided by contraction of certain periurethral muscles. The nerves involved are the sympathetic and the somatic, and there is said to be a center for erection in the lumbar and sacral portions of the cord. Ejaculation takes place reflexly as the result of contraction of the musculature of the vasa deferentia and seminal vesicles aided by voluntary contraction of periurethral muscles. The nerves involved are the sympathetic and the somatic, and there is said to be a center for ejaculation in the lumbar portion of the cord. The sympathetic connections for these two acts are through the lumbar portion of the cord.

In conformity with these data the present opinion appears to be that in men erection takes place as the result of parasympathetic stimulation of the appropriate arterioles, with resultant engorgement of the corpora cavernosa and corpus spongiosum. Associated with this there is compression of the efferent veins of these structures by at least the bulbocavernosus and ischiocavernosus muscles. The reflex is initiated by either tactile stimuli locally or as the result of psychic stimuli. The neural impulses pass both ways over the parasympathetic nerves and the somatic internal pudic nerves. The central-nervous-system center lies in the second, third and fourth sacral segments. "Ejaculation is not a necessary accompaniment of erection. [It is] essentially a reflex reaction." In normal healthy persons the discharge of seminal fluid is elicited only by stimulation of the glans. There is thought to be a summation of impulses, which occurs in the spinal cord. "When such summation has reached the threshold level a sudden discharge of afferent impulses takes place which calls forth sudden contraction of the smooth musculature of the entire sexual apparatus resulting in the propulsion of seminal fluid into the urethra."[10] Afferent impulses reach the spinal cord over the internal pudic nerves, and efferent impulses travel over the sympathetic nervous system by way of the upper lumbar communicating rami and the hypogastric nerves. The presence of seminal fluid in the urethra sets up another reflex with resulting contraction of the constrictor urethrae, bulbocavernosus and ischiocavernosus muscles — all striated and voluntary muscles innervated by the somatic internal pudic nerves. The spinal-cord segments that are involved are the second, third and fourth sacral and the upper lumbar. In the course of the ejaculatory act the prostate is stimulated, its secretion is added to the semen in the prostatic urethra, and the internal vesicle sphincter contracts, blocking off the bladder.[14] Sexual orgasm is associated with

ejaculation and constitutes the sensations caused thereby. It is not known how or where these sensations arise. It need not be assumed that they reach the cerebral cortex. They do, however, give rise to reactions in other visceral organs, and the excitation apparently spreads throughout the autonomic nervous system. They also give rise to somatic reflexes in addition to those activating the periurethral muscles and produce spastic contractions of the extensor muscles of the lower extremities.[10]

## Material

Eighty-four of the paraplegic and paraparetic patients at Cushing Veterans Administration Hospital volunteered for this investigation. Their ages ranged from twenty-one to forty years. In addition, certain data on priapism collected over the years by one of us from a personal series of some 320 civilian injuries of the spinal cord and cauda equina have been included. Table 1 shows the distribution of the Veterans Administration cases by level and diagnosis. Seventy of these 84 patients were interviewed personally. Information regarding the other 14 was obtained by letter. Patients diagnosed as suffering from a transection have been divided into two groups, depending upon the accuracy of verification of the diagnosis. In those diagnosed as Anatomic-Visualized Transection (Tr.-A) the injury has been actually seen at laminectomy to be one in which there is a complete separation of the cut ends of the cord. In those diagnosed as Clinical-Not Visualized Transection (Tr.-C) either the cord injury has not been seen or, if seen, the continuity of the cord was found to be either grossly intact or maintained by intervening scar tissue. The character and length of the clinical course taken by the patients, however, have justified the diagnosis of transection. In both instances, only patients with a complete sensory and voluntary motor loss of function below the level of the cord injury are included as cord transections. Patients diagnosed as suffering from a Partial Cord Injury (P) are those in whom it has been possible to demonstrate some degree of retention of either sensation or voluntary motion, or both, in the body and extremities below the level of maximal cord injury. The same diagnostic criteria have been applied to patients with cauda-equina (C.E.) injuries.

The problems of erection, ejaculation and the patient's ability to impregnate his wife were studied in relation not only to the type and level of cord injury but also to how these functions had been affected by anterior dorsolumbar rhizotomy. The significance of certain analogous functions in the interpretation of loss or retention of sexual capacity has also been considered from the point of view of the innervation of the reproductive organs and has been investigated in terms of anal reflex and type of bladder response to cystometric studies.[15] The figures for these various data are included in Tables 2 and 3.

### *Effects of the Type of Cord and Cauda-Equina Injury*

*On erections.* Sixty-two, or 74 per cent, of the 84 patients had erections after injury. It made no difference so far as the presence of erections was concerned whether the spinal cord or cauda equina was transected or the seat of a partial injury only. One patient with a partial lesion at the level of the fifth lumbar and first sacral segments and another with a transected cauda equina had no erections. Otherwise the level of injury had no effect on this phenomenon.

Table 1. *Distribution of Cases by Diagnosis and Level of Injury.*

| Diagnosis | Level of Injury | | | | Total |
|---|---|---|---|---|---|
| | Cervical | Thoracic | Lumbo-sacral | Cauda equinal | |
| Transection: | | | | | |
| Anatomic visualized | 0 | 27 | 2 | 0 | 29 |
| Clinical not visualized | 1 | 14 | 4 | 1 | 20 |
| Partial injury | 5 | 13 | 11 | 6 | 35 |
| Totals | 6 | 54 | 17 | 7 | 84 |

*On ejaculations.* Only 8 or 7 per cent of the 84 patients had ejaculations after injury. Only 1 patient with a verified anatomic transection of the cord or cauda equina had an ejaculation. Two patients with clinically diagnosed transection of the thoracic cord, however, as well as 4 patients with partial lesions of the cord and 1 with a partial lesion of the cauda equina, did have ejaculations after injury. So far as our experience goes both a transection and a partial injury of the cord will diminish but not eliminate the possibility of ejaculations.

*On ability to impregnate.* Two patients succeeded in impregnating their respective wives after injury. One is reported in detail below. He unquestionably had a transection. There is still a total loss of all sensation and voluntary motion below the sixth thoracic dermatome, his bladder and bowel are reflex and he has involuntary flexor-adductor-extensor muscle spasms of both legs, his abdomen and his back. His clinical condition has not changed for three and three-fourths years. He is able to have intercourse, and has no sensation of orgasm but has an increase in the spasms of his legs and abdomen during ejaculation. He impregnated his wife nineteen months after his injury. The other patient who succeeded in impregnating his wife had a partial injury of the cord at the level of the fifth cervical dermatome. In addition, a patient with an anatomic transection at the eleventh and twelfth dorsal segments claims to be able to have intercourse.

From these figures it can at least tentatively be concluded that erections occur after an injury to the cord or cauda equina, regardless of whether either is transected or the seat of only a partial injury; that it is possible for a patient with a transected cord to have ejaculations; that as far as this small series goes, he will have slightly less than 1 out of 10 chances of having ejaculations regardless of the kind of injury; and that neither a transection nor a partial injury of the cord is necessarily a bar to the patient's ability to impregnate his wife.

### *Effect of Anterior Dorsolumbar Rhizotomy*

Some patients have claimed that the frequency of their erections has been altered for the worse after an anterior dorsolumbar rhizotomy. On the other hand, others have said that the operation has had no such effect, and one has unequivocally stated that whereas before operation he had been unable to produce an erection, erections not only occurred spontaneously but also could be elicited by local stimulation after operation. The operation if properly done divides all the lumbar together with the tenth, eleventh and twelfth thoracic and first sacral anterior roots. Since the division is carried out intrathecally the autonomic as well as the somatic connections made by those roots between the periphery and the central nervous system may be cut. On the other hand, the somatic and parasympathetic segmental nerve supply to the pelvic and reproductive organs is completely spared. It is anatomically possible for either of the above claims to be correct, provided that the observations are competent. In this instance, however, the observations by the patients cannot be considered competent. For one thing, there are too many uncontrolled psychologic factors with unpredictable influences on such a function.

*On erections.* An indication of the effect of this operation on erections can be obtained, however, by a comparison of the known occurrence of this function in patients with and without rhizotomy (Table 2). Twenty-nine, or 34 per cent, of the 84 patients in this series had had anterior rhizotomies, 22 having suffered from transections and 7 being classed as partial lesions of the cord. All the rhizotomies were done on patients with injuries to the thoracic portion of the cord. Twenty-four, or 83 per cent, had erections before and after operation. Five patients had erections before but not after a rhizotomy. In 3 marked uncontrollable oozing of blood accompanied in 2 by extensive adhesive arachnoiditis and difficulty in identifying the roots to be sectioned may be considered adequate cause for an abnormally extensive denervation with resultant loss of erections. No reason is apparent or can be found to account for the loss of erections in the other 2. Fifty-six, or 66 per cent, did not have a rhizotomy, and 36 (64 per cent) of these patients had erections. Failure to have an erection after rhizotomy, therefore, cannot be traced mathematically to the effect of the operation per se.

Of the 7 patients with partial transections who had had rhizotomies, 1 had been operated upon elsewhere. He had sensation but is said to have had no motion at any time below the level of injury, which was at the eleventh thoracic segment. One had sensation and motion below the cord-injury level at the fourth thoracic segment but

TABLE 2. *Effect of Anterior Rhizotomy on Erections in Patients with Injuries at Various Levels of the Spinal Cord.*

| Classification | Injury of Cervical Segments | | | | Injury of Thoracic Segments | | | | Injury of Lumbosacral Segments | | | | Injury of Cauda Equina | | | | Injuries at All Levels | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Anatomic | Clinical | Partial | Total | Anatomic | Clinical | Partial | Total | Anatomic | Clinical | Partial | Total | Anatomic | Clinical | Partial | Total | Anatomic | Clinical | Partial | Total | Percentage |
| Patients with anterior rhizotomy | 0 | 0 | 0 | 0 | 16 | 6 | 7 | 29 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16 | 6 | 7 | 29 | 34 |
| Erections present | 0 | 0 | 0 | 0 | 12 | 5 | 7 | 24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12 | 5 | 7 | 24 | 83 |
| Erections absent | 0 | 0 | 0 | 0 | 4 | 1 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 1 | 0 | 5 | 17 |
| Patients with no rhizotomy | 1 | 0 | 5 | 6 | 13 | 8 | 6 | 27 | 1 | 4 | 11 | 16 | 0 | 1 | 6 | 7 | 15 | 13 | 28 | 56 | 66 |
| Erections present | 1 | 0 | 5 | 6 | 7 | 6 | 5 | 18 | 0 | 2 | 5 | 7 | 0 | 0 | 5 | 5 | 8 | 8 | 20 | 36 | 64 |
| Erections absent | 0 | 0 | 0 | 0 | 6 | 2 | 1 | 9 | 1 | 2 | 6 | 9 | 0 | 1 | 1 | 2 | 7 | 5 | 8 | 20 | 36 |
| Totals | 1 | 0 | 5 | 6 | 29 | 14 | 13 | 56 | 1 | 4 | 11 | 16 | 0 | 1 | 6 | 7 | 31 | 19 | 35 | 85 | |

had such severe spasms that rhizotomy with its flaccid paralysis was preferred to the retention of motion with its necessary accompaniment of spasm. In another with an injury at the eighth thoracic segment the voluntary motion was limited to slight activity in the toes only. Sensation was present but reduced. The other 4 patients never had any voluntary motion below the level of the cord injury at any time. Sensation was present

*On ejaculation.* The effect of anterior dorsolumbar rhizotomy on the occurrence of ejaculations is less apparent. Eight of the 84 patients had ejaculations. Five of these had partial injuries at the fifth cervical, twelfth thoracic, second and fifth lumbar segments and the cauda equina, respectively, and 3 had transections at the second, sixth and eighth thoracic segments, respectively. None of these had had a rhizotomy. Twenty-eight

TABLE 3. *Effect of Spinal-Cord Injury on Various Functions.*

| CLASSIFICATION | INJURY OF CERVICAL SEGMENTS | | | | INJURY OF THORACIC SEGMENTS | | | | INJURY OF LUMBOSACRAL SEGMENTS | | | | INJURY OF CAUDA EQUINA | | | | INJURIES AT ALL LEVELS | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ANATOMIC | CLINICAL | PARTIAL | TOTAL | ANATOMIC | CLINICAL | PARTIAL | TOTAL | ANATOMIC | CLINICAL | PARTIAL | TOTAL | ANATOMIC | CLINICAL | PARTIAL | TOTAL | ANATOMIC | CLINICAL | PARTIAL | TOTAL | PERCENTAGE |
| Patients with erections ..... | 1 | 0 | 5 | 6 | 21 | 11 | 12 | 44 | 0 | 2 | 5 | 7 | 0 | 0 | 5 | 5 | 22 | 13 | 27 | 62 | 74 |
| Patients with ejaculations .... | 0 | 0 | 1 | 1 | 1 | 2 | 1 | 4 | 0 | 0 | 2 | 2 | 0 | 0 | 1 | 1 | 1 | 2 | 5 | 8 | 7 |
| Patients producing pregnancy.. | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 2 | 3 |
| Patients with anal reflex ..... | 1 | 0 | 5 | 6 | 23 | 12 | 11 | 46 | 0 | 1 | 2 | 3 | 0 | 0 | 1 | 1 | 24 | 13 | 19 | 56 | 67 |
| Patients without anal reflex ... | 0 | 0 | 0 | 0 | 3 | 2 | 2 | 7 | 1 | 3 | 9 | 13 | 0 | 1 | 5 | 6 | 4 | 6 | 16 | 26 | 31 |
| Atonic bladder..... | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | 2 |
| Autonomous bladder ..... | 0 | 0 | 0 | 0 | 3 | 2 | 2 | 7 | 1 | 3 | 9 | 13 | 0 | 1 | 5 | 6 | 4 | 6 | 16 | 26 | 31 |
| Reflex bladder ..... | 1 | 0 | 3 | 4 | 21 | 12 | 11 | 44 | 0 | 1 | 2 | 3 | 0 | 0 | 0 | 0 | 22 | 13 | 16 | 51 | 44 |
| Normal bladder ..... | 0 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 3 | 3 | 4 |

but impaired in these cases. The levels of the injuries were the first thoracic segment in 2 cases and the seventh and eighth thoracic segments in the other 2.

The levels of injury in the patients with transected cords who had erections were the second (1 case), second and third (1 case), third (2 cases), third, fourth and fifth (1 case), fourth (1 case), fifth (1 case), sixth (2 cases), sixth and seventh (1 case), seventh and eighth (1 case), eighth (3 cases), ninth (2 cases), ninth and tenth (1 case), tenth (1 case) and twelfth (1 case) thoracic segments. Two others — both transections, one at the tenth and the other at the tenth and eleventh thoracic segments — did not have erections either before or after rhizotomy. One patient with a transection at the fifth dorsal segment had no erections after a second rhizotomy.

It should be noted that there were examples of loss of both motion and sensation and loss of motion with retention of sensation among the patients who had erections after rhizotomy and that virtually all the thoracic segments of the cord were involved. It appears that the proper performance of an anterior dorsolumbar rhizotomy will not affect the occurrence of erections.

other patients had rhizotomies but have not had ejaculations at any time either before or after the operation. They include the 22 thoracic transections and the 7 partial lesions described in detail above. It is impossible to decide on this evidence whether an anterior dorsolumbar rhizotomy, if properly performed, will or will not prevent ejaculations. What evidence there is seems to favor the view that the operation will not affect their occurrence.

*On pregnancy.* Neither of the patients that had produced a pregnancy had had a rhizotomy.

## SEGMENTAL INNERVATION OF THE MALE ORGANS OF GENERATION

"Reflex erection in animals is mediated through centers in the lumbar and sacral segments of the spinal cord and ejaculation through another in the lumbar cord."[10] In man the demonstration of an anal reflex establishes the integrity of the internal pudic nerves — a somatic connection — and their sensory and motor distribution. The presence of a reflex bladder confirms this and also demonstrates the integrity of the parasympathetic plexuses and their central and peripheral connections. These neural pathways are known to have their central

connections in the sacral portion of the cord. It is impossible on the available evidence to be certain of the functions mediated by the sympathetic connections to the pelvic and genital organs in man even though there is increasing evidence that, in some patients at least, disorganization of sympathetic responses throughout the body is connected with distention of the bladder.[16] These neural pathways are known to have their central connections in the lumbar portion of the cord. If the above statements hold true and experimental evidence in animals can be applied to man, erections in human beings should occur whenever the lumbar and sacral segments and their somatic and anatomic connections can be shown to be uninjured. They should be absent when the reverse is true — that is, when the anal reflex is absent, and the bladder is atonic or autonomous or the sphincter atonic.

Six cervical, 40 thoracic (29 transections and 11 partial injuries) and 2 lumbar injuries (1 transection at the second and 1 partial injury at the first lumbar segment) had an anal reflex and either normal or reflex bladders (Table 3). All these patients had erections. On the other hand, 4 patients with transections at the third, sixth and seventh, tenth and tenth and eleventh thoracic segments, 1 with a partial injury at the first lumbar segment and 1 with a partial cauda-equina injury also had anal reflexes and reflex (5) or autonomous (1) bladders but did not have erections. It is thus apparent that with intact somatic and parasympathetic neural connections between the pelvic and reproductive organs and the sacral segments erections were present in 48 and did not occur in 6 cases. Moreover, despite evidence of both transection and partial injury to the thoracic and lumbar segments of the cord erections did occur.

Eleven patients who did not have an anal reflex and had atonic (1) or autonomous (10) bladders had erections as follows: 1 with a partial injury at the twelfth thoracic segment, 1 with a transection at the first lumbar segment, 4 with partial injuries at the first, second, third and fifth lumbar segments, and 5 with partial lesions of the cauda equina. Thus in 11 cases in which the evidence is unquestionably in favor of at least partial denervation of the pelvic and reproductive organs by major damage to their central connections, including virtually all the lumbar segments as well as the cauda equina, erections were nevertheless present. Twelve other patients — 3 with transections at the fifth and sixth, sixth and eleventh thoracic segments, respectively, 1 with a partial injury at the twelfth thoracic segment, 3 with transections at the first thoracic segment, and 5 with partial injuries at the twelfth thoracic and first lumbar, first, second and third lumbar and fifth lumbar and first sacral segments gave evidence of interrupted parasympathetic and somatic connections in that they had no anal reflex and atonic (1) and autonomous (11) bladders. They also had no erections. Attention is again called to the 28 patients with transections of the thoracic segment and the 7 with partial injuries of the thoracic segments who had rhizotomies. In all the patients with transections the pelvic and reproductive organs were cut off not only from all suprasegmental connections but also from the motor side of the lumbar cord. All but 1 of these patients had an anal reflex, and all but 3 (2 autonomous and 1 chemical cystitis) reflex bladders. All but 5 had erections. The same observation held true in the partial injuries so far as the anal reflex and the bladder went. Moreover, sensation in the body and extremities below the upper level of cord injury was present to some extent. All these patients had erections. On this evidence, therefore, it appears that in man erections may or may not occur in the presence of intact somatic and parasympathetic segmental connections between the central nervous system and the pelvic and reproductive organs. Furthermore, an intact lumbar cord and its motor connections are not necessary for their production. Clinical absence of such connections as evidenced by an absent anal reflex and an atonic or autonomous bladder is not necessarily a bar to the presence of erections.

The same criteria can be used to measure the integrity of these neural connections in relation to the occurrence of ejaculations. As noted above, ejaculations were absent in all but 8 cases. One patient with a partial lesion of the fifth cervical segment, 3 with transecting lesions of the second, sixth and eighth thoracic segments, 1 with a partial lesion of the twelfth thoracic segment, 2 with partial lesions of the second and fifth lumbar segments, and 1 with a partial lesion of the cauda equina had ejaculations. None had had a rhizotomy. The patient with the cervical lesion and the 3 with thoracic transections had reflex, but all the rest had autonomous bladders. Six of these patients had had an anal reflex, which was absent in the others. The patients with partial injury at the fifth cervical and transection at the sixth thoracic segment impregnated their wives. Patients with injuries similar in level and pathology and with both absent and present anal reflexes, as well as both reflex and autonomous bladders and with and without rhizotomies, did not have ejaculations. If it is true that to have an ejaculation the periurethral muscles must be innervated and at least reflexly active by way of the internal pudic nerves and if there is no other strictly anatomic factor involved, only patients with totally destructive lesions of the sacral or at most the lumbosacral segments of the cord or with transecting or totally destructive lesions of the cauda equina should be unable to have ejaculations. Thus, none of these patients in this series

who had ejaculations would necessarily be deprived of that ability (since they had only partial lesions). It is impossible to be certain in any given cord injury, however, how far below the level of maximum damage the lesion has extended. A level at the first lumbar segment, for example, may have produced changes that are undemonstrable clinically at any point down to the tip of the conus. Such a hypothesis would account for the fact that 2 patients with signs of transection at the tenth and eleventh thoracic segments, respectively, and 1 with a partial lesion at the twelfth thoracic segment had absent anal reflexes, autonomous bladders and no ejaculations. At least one of them (at the eleventh thoracic segment) was known to have an extensive atrophy of all the cord below the level of transection. On the other hand, 2 patients with verified transections at the sixth and seventh and tenth and eleventh thoracic segments, as well as 1 with a clinical transection at the tenth thoracic segment, also had no ejaculations but *did* have an anal reflex and reflex bladders. It appears that, unlike the function in animals, the ability to have an ejaculation in man does not rest solely on an intact upper lumbar segment of the cord.

## Priapism

Priapism: "persistent abnormal erection of the penis, usually without sexual desire."[17] There is a medical tradition — undocumented to be sure — that priapism may be expected constantly to accompany severe cervical cord injuries. In times past, this relation has been considered to be of diagnostic significance. An analysis of 320 injuries of the spinal cord and cauda equina demonstrates that these beliefs are not in accordance with the facts. A note regarding the presence of priapism was made in 221 male patients of the total series of 320. There were 122 injuries of the cervical segments, 46 of the thoracic, 21 of the lumbosacral and 34 of the cauda equina. Priapism was present in 22 or 10 per cent. It was most common in the cervical group, appearing in 17 cases, or 14 per cent. It was also present in all the other groups as follows: thoracic, 3 out of 46, or 6.5 per cent; lumbosacral, 1 out of 21, or 5 per cent; and cauda equinal, 1 out of 34, or 3 per cent. It is undoubtedly of pathologic significance when it does occur. It is apparent from these figures that priapism may occur in association with a spinal-cord or cauda-equina injury at any level. It occurs most frequently as an accompaniment of cord injuries of the cervical segment but not frequently enough to be of any diagnostic significance.

## Case Report

Because of its importance to other paraplegic patients the following account of a paraplegic patient's successful impregnation of his wife is included. The details have been furnished by the couple, and the text that follows has been reviewed by them and has their approval.

This patient, now 27 years of age, was injured in October, 1944, by a bomb fragment, which struck him in the region of the sixth and seventh thoracic vertebras. As a result he developed a complete motor and sensory paralysis below the level of the xiphoid. A laminectomy was performed in September, 1945, and the cord was described in the report of this operation as being discolored and closely adherent to the surrounding scarred dura but without obvious anatomic transection. There has been no return of function since the injury.

Before and after this laminectomy he had moderately severe leg and abdominal spasm, for which rhizotomy had been recommended and refused.

Three months after the injury his urethral catheter, which he had worn till then, was removed. He has been able to void since then by manual compression of the bladder but maintains nevertheless, varying amounts of residual urine. A transurethral resection of the internal sphincter was advised but refused.

About 1 month after injury he began to have spontaneous erections lasting from 1 to 20 minutes. They had no relation to cerebral activity. The patient then discovered that erections could be caused by local stimulation of the penis. About 10 months after injury he attempted masturbation for the first time. After this stimulation he obtained a brownish-red ejaculate. A week later he repeated the procedure with essentially the same result. Since then ejaculations have been described as being normal in appearance, substance and quantity. During ejaculation, the patient's spasms increase momentarily, but no other sensation occurs.

He was married to a nurse, aged 25 years, in May, 1946. Intercourse was timed to correspond with his wife's periods of intermenstrual pain (Mittelschmertz). His wife's last menstrual period prior to delivery began on May 31, 1946, and she was delivered of a normal, full-term child on March 1, 1947.

## Discussion

When the material that has been collected as the result of this study (Table 4) is applied to the few observations hitherto made on man and to the deductions made from animal experiments, it is evident that except for certain details the mechanism of erection and ejaculation as described by Kuntz is correct.

Table 4. *Effect of Injuries at Various Levels on Erections and Ejaculations.*

| | | | | |
|---|---|---|---|---|
| | Transections Only | | | |
| Erections present in patients with injury between | T1* | Yes | L3 | |
| | | T6 | No | Conus |
| Ejaculations present in patients with injury between | T2 | Yes | T6 | |
| | T2 | | No | Conus |
| | All Cases | | | |
| Erections present in patients with injury between | C4 | Yes | L5 | |
| | | T6 | No | Cauda equina |
| Ejaculations present in patients with injury between | C4 | Yes | | Cauda equina |
| | C4 | No | | Cauda equina |

*The letters and figures refer to spinal-cord segments.

### *Erections*

It is apparent from our series and from earlier studies of bladder innervation that erection takes place on a purely segmental-reflex basis and that suprasegmental connections are unnecessary. In paraplegic patients the afferent sensory impulses that initiate the reflex are caused by tactile stimula-

tion of the glans and travel to the second, third and fourth sacral segments by way of the internal pudic nerves. Efferent impulses leave these same segments by way of the parasympathetic supply and cause dilatation of the arterioles of the penis, with distention and congestion of the corpora cavernosa and spongiosum. In addition, efferent impulses leave the same segments over the internal pudic nerves to cause contraction of the periurethral muscles, with resultant compression of the venous drainage channels of the penis.

Our series indicates that destruction of the sacral segment of the cord or transection and destruction of the cauda equina and the pelvic parasympathetic plexuses are the only neurologic, anatomic lesions that will prevent the occurrence of erections. Associated with such absence will be an autonomous bladder, an absent anal reflex and possibly atonic urethral sphincters. Erections occur in the presence of all other cord injuries, whether partial or transecting, and regardless of the level involved.

*Ejaculations*

Our series indicates that ejaculation is basically a complex purely spinal segmental reflex function. Suprasegmental connections are not necessary for the act. Our findings differ from those of Kuntz and others in that we believe our evidence indicates that destruction or maintenance of the low thoracic and high lumbar sympathetic central connections is the important link in this particular neurologic chain. In this connection we have demonstrated that ejaculations were absent in 28 low thoracic and upper lumbar transections between the sixth thoracic and third lumbar segments. Moreover, of those patients in whom ejaculations were present the injury, except in 1 patient with a transection at the eighth thoracic segment, was outside this area. Two patients, 1 with a transection of the sacral segment and another with a transection of the cauda equina, as well as a patient with a partial lesion at the fifth lumbar segment, had no ejaculations. Otherwise identical cord injuries produced ejaculations in 1 case but not in another.

We interpret these data to mean that to prevent ejaculations the cord damage must be between the sixth thoracic and third lumbar segments and must be extensive within these limits. Since it may be accepted as fact that the impulses that control the first part of the ejaculatory act travel over the sympathetic nervous system, we believe that it is not so much the cord damage in general that acts as a preventive but rather its location and extent within the cord. In support of this contention, in part at least, we call attention to the fact that although no patient with a transection who had had ejaculations had had an anterior dorsolumbar rhizotomy, there were 54 patients who had not had a rhizotomy, as well as 28 who had, that had no ejaculations either before or after the operation. Such rhizotomies divide all efferent sympathetic connections from the eleventh dorsal through the first sacral segment, and may effectively prevent ejaculation. On the other hand, the tremendous overlap of the sympathetic supply is well known and might serve to maintain neurologic connections between the central nervous system and the smooth musculature of the seminal vesicles, the vasa deferentia and the ejaculatory ducts in spite of such widespread sympathetic denervation.

The second step in ejaculation is also basically reflex, is initiated, according to Kuntz and others, by the sensory impulses set up by the presence of semen in the posterior urethra and sets off efferent impulses, which innervate the periurethral muscles and which result in the actual ejaculation of the semen from the meatus. These afferent and efferent impulses travel over the internal pudic nerves by way of the second, third and fourth sacral segments. As would be expected, the patients with transections of the sacral segments and the cauda equina had no ejaculations.

Our evidence indicates that ejaculations will be prevented by a destructive lesion of the sacral segments of the cord or a transecting lesion of the cauda equina. If the damage is extensive enough and properly placed in the cord ejaculation will also be prevented by either transecting or partial injuries of the cord between the sixth thoracic and third lumbar segments, depending upon the degree of destruction of the sympathetic components in this area of the cord. Complete detachment of the sympathetic system from the anterior aspect of the cord between the eleventh thoracic and first sacral segments may or may not prevent ejaculation, the evidence being inconclusive at present. There is no "center" for ejaculation in the lumbar portion of the cord or anywhere else.

*The Orgasm*

We have no data on the occurrence of an orgasm in connection with ejaculation except in the case reported above in detail. This suggests that a thoracic transection will do away with the sensation of orgasm and that orgasm of the male is not essential for successful impregnation.

*Sterility*

To impregnate successfully, the semen must have an adequate count of viable motile spermatozoa. The question arises whether or not spinal-cord injuries affect this aspect of the problem. It is known that the spermatozoa are stored in the seminal vesicles, having been transferred there by the ciliary action of the vas deferens. It is not known whether muscular contractions are necessary in addition. In any event, it appears to be true that any strictly neural activity that takes place does so by way of the sympathetic system, which is known to supply the vasa, the vesicles, the prostate and ejaculatory

ducts. A more detailed study of this aspect of the problem will follow in a later paper.

## Conclusions

It seems reasonable to conclude until more extensive studies can be made that, unless he has a destructive lesion of the sacral cord, a transection of the cauda equina or injury to the cord between the sixth thoracic and third lumbar segments extensive enough to interrupt completely the thoracolumbar sympathetic outflow, a patient can and should be potent — that is, he should be able to have erections and to ejaculate — and that unless other abnormalities prevent it, he will be fertile and capable of producing pregnancy.

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# OBSERVATIONS ON THE ETIOLOGIC RELATIONSHIP OF ACHYLIA GASTRICA TO PERNICIOUS ANEMIA*

## X. Activity of Vitamin $B_{12}$ as Food (Extrinsic) Factor


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IT HAS been shown that various foods — for example, beef skeletal muscle,[1] milk[2] and eggs[3] — contain a heat-stable, unidentified substance,[4] the so-called extrinsic factor. When such a source of extrinsic factor as beef muscle is ingested by a patient with pernicious anemia, untreated or in relapse, it produces little or no hematopoietic effect unless normal human gastric juice is also administered, either simultaneously or at least within six hours.[5] The very small amount of the gastric secretion of the patient with pernicious anemia thus apparently supplies little or none of the heat-labile substance, possibly an enzyme,[6-8] that is responsible for the activity of the so-called intrinsic factor of normal human gastric juice when administered with beef muscle. Gastric juice when given without opportunity for contact with beef muscle or with components of an unrestricted diet possesses no hematopoietic power.[5] Despite claims to the contrary,[9] incubation of mixtures of beef muscle and gastric juice does not produce the heat-stable, antipernicious-anemia principle of liver in vitro.[6] Although there is reason to believe that contact between beef muscle and gastric juice at or near a neutral reaction within the intestinal tract is required for hematopoiesis,[6] attempts to concentrate hematopoietic substances from incubated mixtures of beef muscle and gastric juice have given inconsistent results at best. These observations are compatible with the theory that the patient with pernicious anemia requires intrinsic factor to utilize extrinsic factor at some stage in the production of the antipernicious-anemia principle of liver, but that a direct reaction between extrinsic and intrinsic factors does not necessarily occur.

Extrinsic factor is presently recognizable only by virtue of its hematopoietic potency upon oral administration in pernicious anemia with normal


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human gastric juice. Consequently, we have assumed as a working hypothesis that the greatly increased hematopoietic activity in pernicious anemia of liver[10] and of relatively crude liver extracts[11] when ingested with normal human gastric juice indicated the presence of both the extrinsic factor and the antipernicious-anemia principle. Recently, however, we have found that refined liver extracts when given by mouth are also potentiated in their hematopoietic activity by gastric juice, as shown by the following observation, which was conducted according to the methods referred to below.

A patient with pernicious anemia and an initial red-cell count of 2,540,000 was given 1 cc. of solution of liver extract, purified (Lederle), containing 15 *U.S.P.* units (injectable), daily by mouth for ten days. A reticulocyte peak of 3.4 per cent was attained on the seventh day. During a second consecutive ten-day period, the simultaneous administration of normal human gastric juice with the same amount of liver extract produced a second reticulocyte peak of 6.6 per cent at an initial red-cell level of 2,980,000. In other patients it was shown that hydrolysis of liver extracts with dilute sulfuric acid, which apparently destroyed most of the antipernicious-anemia principle, also prevented the material from being potentiated by normal human gastric juice.

With the isolation[12] of crystalline vitamin $B_{12}$, which behaves so far as is now known like the classic antipernicious-anemia principle of liver,[13, 14] the effect of normal human gastric juice on the activity of the pure substance when orally administered could for the first time be tested. Accordingly, 5 microgm. of vitamin $B_{12}$* dissolved in 125 or 150 cc. of physiologic saline solution was given daily by mouth during a first ten-day period to 4 patients with untreated pernicious anemia. Immediately thereafter in a second ten-day period, the same amount of vitamin $B_{12}$ was given by mouth simultaneously with 125 or 150 cc. of previously neutralized normal human gastric juice to each patient. The methods of dietary control, of obtaining normal human gastric juice and of blood study employed in these observations have previously been described,[1, 5] as has the interpretation of successive reticulocyte responses.[15] Particular attention was paid to administering the gastric juice at times as widely separated as possible from meals to minimize possible contact between the patient's food and the gastric juice. As an additional control on any hematopoietic effect of the gastric juice on the food, 3 patients (Cases 102, 103 and 104) received gastric juice during the first period twelve hours before each dose of vitamin $B_{12}$.

As shown in Table 1, in each case a reticulocyte response was observed during Period II. Except in Case 104, this was accompanied by a significant increase of red cells and indicates the greater hematopoietic effect of vitamin $B_{12}$ given simultaneously with normal human gastric juice. The reticulocyte peaks were not marked in Period II of Cases 103 and 104. However, no hematopoietic effect whatever was noted during Period I, and significant clinical improvement did not begin until the reticulocyte response appeared in Period II of the observations on these 2 patients. In Case 104, during Period III, 5 gamma of vitamin $B_{12}$ was given intramuscularly daily. This resulted in a striking second reticulocyte response.

TABLE 1. *Potentiation of Hematopoietic Activity of Orally Administered Vitamin $B_{12}$ by Normal Human Gastric Juice.*

| Case No. | Ten-Day Period No. | Red-Cell Count | | Reticulocyte Peak | | Daily Therapy* |
|---|---|---|---|---|---|---|
| | | initial $\times 10^6$ | final $\times 10^6$ | % | day | |
| 101 | I | 1.56 | 1.91 | 5.7 | 8 | 5 gamma of vitamin $B_{12}$† at 8 p.m. |
| | II | 1.82 | 2.72 | 9.3 | 7 | 5 gamma of vitamin $B_{12}$ and 150 cc. of gastric juice at 8 p.m. |
| 102 | I | 1.79 | 1.74 | 2.5 | 10 | 5 gamma of vitamin $B_{12}$† at 8 a.m.; at 8 p.m., 150 cc. of gastric juice. |
| | II | 1.65 | 2.45 | 16.7 | 7 | 5 gamma of vitamin $B_{12}$ and 150 cc. of gastric juice at 8 p.m. |
| 103 | I | 1.62 | 2.12 | none | none | 5 gamma of vitamin $B_{12}$† at 8 a.m.; at 8 p.m., 150 cc. of gastric juice. |
| | II | 1.90 | 2.54 | 3.8 | 8 | 5 gamma of vitamin $B_{12}$ and 150 cc. of gastric juice at 8 p.m. |
| 104 | I | 2.16 | 1.93 | none | none | 5 gamma of vitamin $B_{12}$† at 9 a.m.; at 9 p.m., 125 cc. of gastric juice. |
| | II | 2.14 | 2.10 | 3.8 | 10 | 5 gamma of vitamin $B_{12}$ and 125 cc. of gastric juice at 9 p.m. |
| | III | 1.91 | 2.57 | 14.0 | 8 | 5 gamma of vitamin $B_{12}$ intramuscularly. |

*Given orally unless otherwise indicated.
†Suspended in 125 or 150 cc. of physiologic saline solution.

## Conclusions

These observations indicate that the hematopoietic activity in pernicious anemia of orally administered vitamin $B_{12}$ is potentiated by the simultaneous administration of normal human gastric juice but, as with liver extracts, is not so great as the activity of the vitamin $B_{12}$ when given parenterally. It is suggested, therefore, that the food (extrinsic) factor may be identical with or closely related chemically to the antipernicious-anemia principle of liver, which is itself presumably identical with vitamin $B_{12}$. It is further suggested that the gastric

*Kindly supplied for clinical use by Dr. Augustus Gibson, of Merck and Company, Incorporated, Rahway, New Jersey.

(intrinsic) factor is necessary for the optimal utilization of the relatively small amounts of vitamin $B_{12}$ or of chemically related substances present in various foods.

Preliminary microbiologic findings with the use of *Lactobacillus leichmanii* (A.T.C.C. 4797) in an untreated patient with pernicious anemia suggest that the fecal elimination of vitamin $B_{12}$ is of such magnitude that either the vitamin derived from the food, or more probably that synthesized by intestinal bacteria, is not absorbed in sufficient amounts to abolish the deficiency. (Since this manuscript was submitted for publication Bethell and his associates[16] have reported the results of microbiologic observations demonstrating large daily fecal excretions of vitamin $B_{12}$ in 4 cases of untreated pernicious anemia, and from this fact have drawn similar conclusions.) Other observations suggest that material soluble in 70 per cent alcoholic extracts of beef muscle, a classic source of extrinsic factor, when prepared in a form suitable for parenteral administration, possesses both microbiologic activity as vitamin $B_{12}$ and hematopoietic activity upon intravenous injection in pernicious anemia. It is therefore possible that the function of the intrinsic factor of normal human gastric juice is to facilitate the absorption by the intestine of vitamin $B_{12}$ or of chemically related compounds in the food, rather than to react with the extrinsic factor as hitherto assumed.

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# DIPHTHERITIC MYOCARDITIS*


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DIPHTHERIA has shown a striking rise in incidence over the entire world in the last five years. Although the rate of occurrence in the United States as a whole has remained at a static level during this period, some parts of the country have experienced a disturbing increase. In Massachusetts, for example, the number of cases has risen from 123 in 1941 to 439 in 1946 and 440 in 1947. This change, together with the prevalence of the disease in the armed forces in various areas of the world during the war, has aroused again an interest in the study of this infection. The purpose of this report is to re-emphasize the important effects of diphtheria on the heart as determined by electrocardiographic examination.

The cases of diphtheria reported below occurred mainly in 1946 and 1947; some patients observed in the preceding two years and a few admitted in the early part of 1948 are included. During this period 140 patients with diphtheria were admitted to the Haynes Memorial Hospital (the Infectious Disease Department of the Massachusetts Memorial Hospitals); electrocardiograms were taken at periodic intervals in all cases. Casual electrocardiographic examination through the course of the disease was shown to be wholly inadequate because it was observed that changes might occur in the first few days of the disease or not until after several weeks and were not infrequently very transient. It became evident that, to demonstrate short-lived variations from the normal, electrocardiograms had to be made almost daily from the time of admission to the hospital until convalescence was well established. This point deserves special emphasis because without, fre-


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quently repeated studies a true estimate of the occurrence of diphtheritic myocarditis cannot be made. That such a practice is not widely adopted is borne out in the report of Kay and Livingood[1] on the cardiac complications of diphtheria of the skin. These investigators recommended that tracings be taken in mild cases about every two weeks until three weeks after the cutaneous lesions have begun to heal and every week or ten days until about seven weeks after the onset of the lesions in patients with severe cutaneous diphtheria.

In the beginning, our failure to appreciate the need for frequent electrocardiograms necessitated the elimination of 47 patients from our series because of too few tracings. Arbitrarily, five records taken during the course of the illness were considered the minimum adequate number, although it is almost certain that in some cases this was wholly inadequate for discovering transient changes. The cases were unselected, so that both severe and mild ones were included.

The degree of electrocardiographic abnormality was graded from 1 to 4. Grade 1 consisted of prolongation of the PR or QT intervals, or slight alterations in the ST segment or T wave. Grade 2 variations were either more marked or consisted of a combination of those classified as Grade 1. Grade 3 was made up of records showing the same changes as those in Grade 2 (but more intense), whereas the designation of Grade 4 was reserved for cases of complete auriculoventricular block, bundle-branch block, ventricular tachycardia or very marked aberrations of the ST segments or T waves. Usually several, or all, of these abnormalities occurred simultaneously or appeared in successive records on the same patient. Particular care was taken to exclude any unusual findings that might reasonably be attributed to tachycardia during the early toxic phase of diphtheria or to serum reactions.

Figure 1 illustrates Grade 1 changes in 3 patients. These consist of lowering or flattening of the T waves with sagging of the ST segments; although they may occur in all leads, they were considered significant only when present in Leads 1 and 4.

Figure 2 shows Grade 2 alterations in 2 cases. In the first (G. C.), the ST segments were displaced, and there was slight prolongation of the PR interval. This was the only case of reciprocal displacement of the ST segments. In all the others the ST segments were directed downward in all the affected leads.

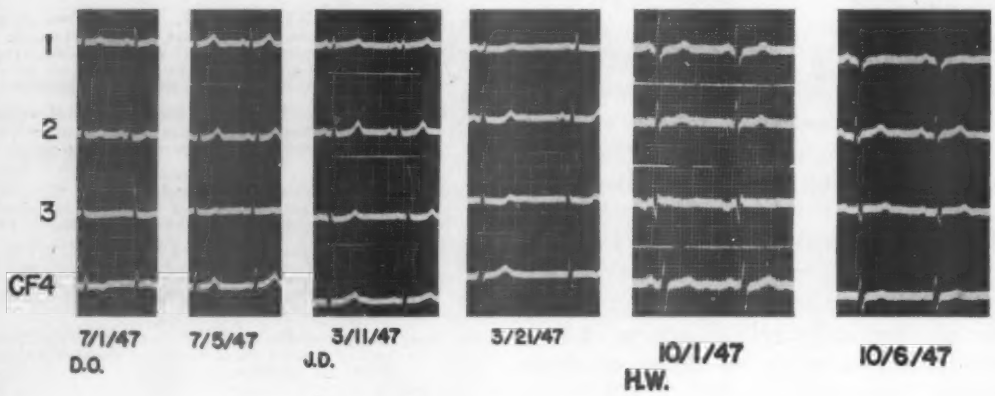


FIGURE 1. *Grade 1 Changes.*

*D. O., a twenty-three-year-old woman, was admitted to the hospital on the third day of disease. She received 50,000 units of antitoxin. On the sixth day of illness the ST segments showed slight sagging. By the fourteenth day changes in the T waves had become maximal and are shown over the date "7/1/47". Four days later the record was normal and remained so. There were no other signs of cardiac involvement.*

*J. D., a fifteen-year-old boy, was admitted to the hospital on the tenth day of disease; he received 20,000 units of antitoxin. The record on the fourteenth day of disease was considered within normal limits. On the eighteenth day ST-segment changes appeared and were maximal on the twenty-fifth day. The electrocardiogram was slightly abnormal at discharge on the fifty-third day. There were no other signs of cardiac involvement.*

*H. W., a forty-eight-year-old woman, was admitted to the hospital on the fourth day of disease. She was given 20,000 units of antitoxin. The record on the fifth day of the disease was considered normal. Minor T-wave changes appeared on the ninth day and had become maximal on the twelfth day. Changes persisted until the twenty-fourth day. No other signs of cardiac involvement appeared.*

Figure 2 exemplifies the characteristic change in the ST segments and T wave, which is very similar to that produced by digitalis. In addition there are "splintering" without widening of the QRS complex and development of deep S waves in Leads 2 and 3.

The electrocardiograms characteristic of Grade 3 are presented in Figure 3. The earliest detectable abnormality, prolongation of the QT interval, appeared on the seventh day of the disease. This was soon followed by progressive sagging of the ST segments and an increasing degree of inversion of the T waves in Leads 1, 2 and $CF_4$, which per-

sisted until the patient's death on the forty-seventh day after the onset of diphtheria. Aside from some increase in heart size, there were no signs of cardiac involvement, such as murmurs or gallop, and no congestive phenomena. Autopsy showed very marked generalized fibrosis, but, by that time, all the inflammatory cellular reaction had subsided.

Figure 4 is an example of Grade 4 since it demonstrates complete auriculoventricular block; there are also marked ST-segment and T-wave changes. This patient died of bronchopneumonia on the forty-seventh day. The record taken on the day before death showed considerable improvement. Histologic examination of the myocardium revealed widespread fibrosis, however.

Grade 4 electrocardiograms of 4 patients are illustrated in Figure 5. These tracings reveal the most severe abnormalities — namely, ventricular tachycardia, complete auriculoventricular block and widened QRS complexes. The widened QRS complexes in patients R. H. and R. G. may have been due either to bundle-branch block or to origin of the impulse somewhere below the junctional tissue. The only patient who developed auricular

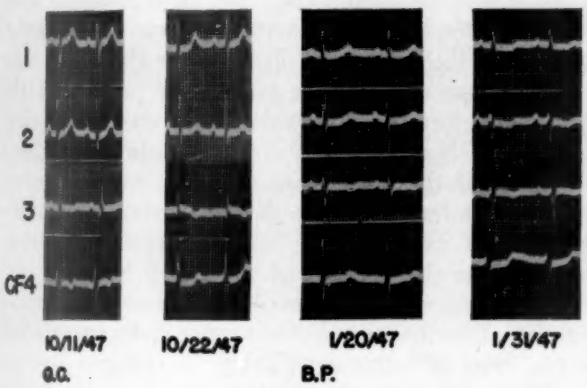


FIGURE 2. *Grade 2 Changes.*

*G. C., a five-year-old girl, was admitted to the hospital on the third day of disease. She received 20,000 units of antitoxin. The record labeled "10/11/47" was taken on the fourth day of disease and was normal. Maximal ST changes were recorded on October 22. Two days later the ST segments had returned to normal, but the QT interval was prolonged. A record on October 30 was normal. There were no other signs of cardiac involvement.*

*B. P., an eleven-year-old girl was admitted to the hospital on the sixth day of disease. She was given 50,000 units of antitoxin. The first record to be made (marked "1/20/47") was on the eleventh day of disease. The QT interval was prolonged, but otherwise the record was normal. Two days later ST-segment changes appeared and became maximal. The record became normal on the thirty-eighth day of disease. From the twenty-first to the twenty-third day gallop rhythm, an apical systolic murmur and frequent premature beats were present.*

fibrillation (preceded by flutter) was G. C. She also had complete auriculoventricular block since the ventricular rate was 115 and regular. The voltage of the QRS complexes decreased markedly from that found in earlier records, and comparatively deep S waves appeared in Lead 1.

Table 1 indicates the relative frequency of electrocardiographic abnormalities during the course of diphtheria. Seventeen (18.2 per cent) of the 93 patients showed normal records throughout. It should be noted, however, that the average number of records per patient in this group was only seven, and only 4 of the 17 patients had more than eight. In view of the transient nature of the changes with myocardial involvement, it seems probable that, had more tracings been made, significant variations

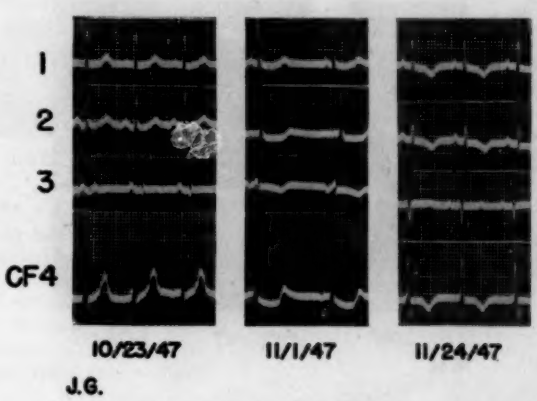


FIGURE 3. *Grade 3 Changes.*

*J. G., a fifty-two-year-old man, was admitted to the hospital on the fourth day of disease. He received 100,000 units of antitoxin. The record dated "10/23/47" was made on the fifth day of disease and was normal. Two days later the QT interval was prolonged, and auricular premature beats appeared. Progressive ST-segment changes appeared and reached their maximum on November 1 — shown above. As the ST segment changes regressed progressive T-wave inversion appeared, reaching maximum inversion on November 24. These changes persisted until death on the forty-seventh day of disease. The heart size was increased on both physical and x-ray examination, but there were no other signs of cardiac involvement. Concomitantly widespread polyneuritis appeared, and, terminally, signs of bronchopneumonia. Histologic examination showed extremely marked, generalized fibrosis and some muscle fragmentation, but no acute degeneration or inflammatory cellular reaction. The coronary arteries revealed slight intimal thickening but were patent throughout.*

would have been detected in cases in which no cardiac dysfunction was apparent.

An almost equal number of patients (16.3 per cent) showed electrocardiographic findings that were neither clearly normal nor abnormal. The main difficulty lay in the interpretation of T-wave changes in Lead $CF_4$. Since only one chest lead was taken, alterations in the T waves from day to day could often be attributed to difference in the position of the exploring electrode. Arbitrary standards were adopted as follows: an inverted T wave in Lead $CF_4$ was accepted as normal if the R:S ratio was less than 1. If the R exceeded the S wave by 50 per cent or more an inverted T wave was considered abnormal. Records that did not fall into either of these categories were considered borderline. Questionable T-wave changes in Lead $CF_4$ accounted for 9 of the 15 borderline cases. In the remainder the QT interval, ST segments or T

waves showed changes that were probably, although not certainly, significant.

Sixty-one patients (65.5 per cent) showed incontestable abnormalities; of these, the majority (65.5 per cent) were slight (Grade 1) and usually transient.

The relative frequency of individual abnormalities is illustrated in Table 2. Multiple deviations from the normal were more usual than isolated

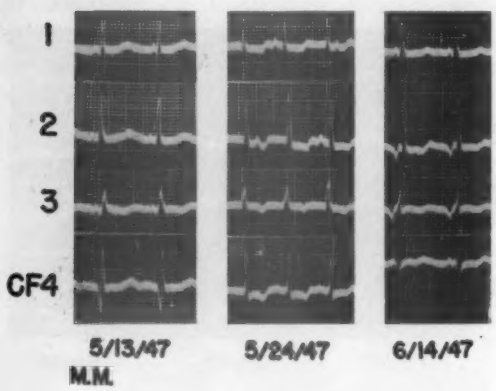


FIGURE 4. *Grade 4 Changes.*

*M. M., a fifty-five-year-old woman, was admitted to the hospital on the seventh day of disease. She was given 100,000 units of antitoxin. The record dated "5/13/47" was made the day after admission — the eighth day of disease — and showed prolongation of the QT interval (the precordial lead was reversed). ST-T changes and complete auriculoventricular block appeared in the next few days and remained constant until June 3, when the block disappeared and ST-T reverted toward normal. On the day before death the record dated "6/14/47" was made, showing considerable change toward normal. There were no other signs of cardiac involvement. On the thirty-seventh day of disease polyneuritis developed, with regurgitation of food and inability to swallow. Aspiration pneumonia followed, and death occurred on the forty-seventh day. At autopsy the myocardium showed diffuse fibrosis.*

ones, although variations in the ST segment or T waves, or both, not infrequently occurred alone. It is noteworthy that 1 patient, who showed Grade 4 changes (ventricular tachycardia) for a short period, had only minor electrographic findings before and after the period of rapid pulse. This was the only one of the group of patients with myocarditis of the most severe degree who survived.

Data regarding the relation of age to the occurrence of abnormal electrocardiograms are presented in Table 3. About a third of the patients were twenty years of age or over, and two thirds were younger. The average age of those showing significant findings was two and a half times that of those with normal records. Furthermore, the age range was much narrower for those with normal or borderline tracings. The oldest patient with a normal electrocardiogram was thirty years of age; the oldest with borderline variations was thirty-three years, and the oldest with distinct abnormalities seventy-two years old. Only 4 of those (12.5 per cent) who had no laboratory evidence of myocarditis were twenty years of age or older, whereas 30 (50 per cent) of those with abnormal records were over twenty years of age. As well as could be ascertained from the small number of cases in each of the grades of myocardial disease, age did not seem to determine the degree of electrocardiographic aberration.

On the whole the onset of electrocardiographic abnormalities was earlier than has been usually thought, the average being eleven and a half days after the inception of the diphtheria. These figures include patients with abnormal records on admission, the day of admission being counted as the day the electrocardiogram became abnormal. Since 34 per cent were abnormal on admission, with an average duration of disease of nine and three-fourths days, it is apparent that the true average time of onset is less than the above figure indicates. The exact time of the first occurrence of myocardial disease was not known in about a third of the patients, since the electrocardiograms were abnormal on entry into the hospital. The earliest abnormal record was encountered on the third, and the latest on the forty-seventh day of the disease.

The interval between the onset of diphtheria and the institution of antitoxin therapy was not greatly different in the various groups (Table 4). The average delay was only a little greater for patients with abnormal electrocardiograms, but was especially notable in those who developed Grade 4 changes. However, of the 9 patients in the latter category, 2 were not admitted to the hospital until the seventeenth and twenty-first days respectively; these cases weight the average of the group heavily.

The development and evolution of electrocardiographic abnormalities did not appear to be related to the type of organism (Table 5). Gravis strains predominated in patients with Grade 4 findings; the small number of cases makes such an observation of dubious significance, however.

The over-all mortality (Table 6) was 14.4 per cent for the series. There were no deaths among the patients who had normal or borderline electrocardiograms. The number of deaths rose steadily with increase in intensity of the electrocardiographic aberrations, being 5 per cent in the patients with Grade 1, 14 per cent in those with Grade 2, 40 per cent in those with Grade 3 and 78 per cent in those with Grade 4 changes.

## DISCUSSION

Significant electrocardiographic abnormalities appeared to be much more common in the cases of diphtheria in this series than in those reported in other studies. The usual incidence of myocarditis has been thought to be between 10 and 20 per cent.[2, 3] Begg,[4] however, found changes in the electrocardiographic records in 84 per cent of 100 selected cases of severe diphtheria. This figure is

in close agreement with that obtained in our group, which included both severe and mild cases. Frequent electrocardiograms appeared to provide the only certain means of detecting myocarditis, of 3 patients displayed no abnormalities at any time.

The pathological characteristics of fatal diphtheritic myocarditis have recently been reviewed

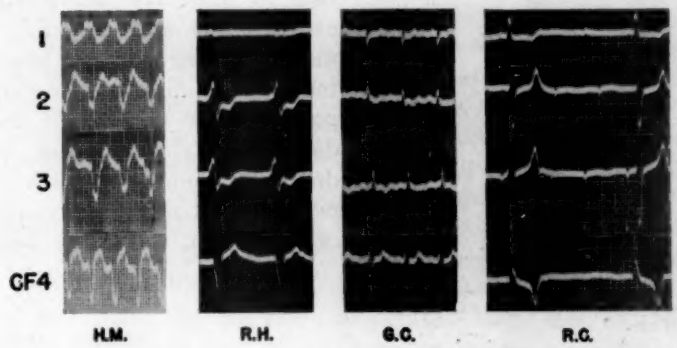


FIGURE 5. *Grade 4 Changes.*

*H. M., an eight-year-old boy, was admitted to the hospital in the third week of disease with palatal paralysis and gallop rhythm. The electrocardiogram on admission showed complete auriculoventricular block, with a ventricular rate of 80 and marked ST-T changes. Just before death the record demonstrated ventricular tachycardia.*

*R. H., an eleven-year-old boy, was admitted to the hospital on the seventeenth day of disease. He was given 10,000 units of antitoxin. Ventricular tachycardia was present on admission. On the day of death the above record was obtained.*

*G. C., a nine-year-old girl, was admitted to the hospital on the fifth day of disease. She received 60,000 units of antitoxin. The electrocardiogram on the day after admission showed ventricular tachycardia, which persisted for four days. On the next day complete auriculoventricular block, with a ventricular rate of 110 and marked ST changes but with normal QRS complexes, was present. On the following day auricular flutter appeared, followed shortly by auricular fibrillation. After five days the auricular fibrillation disappeared and was replaced by complete auriculoventricular block and progressive QRS changes up to the time of death on the thirty-fifth day.*

*R. C., a twelve-year-old boy, was admitted to the hospital on the fifth day of disease. He was given 40,000 units of antitoxin. On admission the heart was enlarged, and the rate was 35 per minute. Complete auriculoventricular block and widened QRS complexes were present.*

since reliable physical signs of heart disease were never present in patients with the lesser grades of deviation from the normal and those with a high degree of electrocardiographic abnormality often revealed surprisingly little on examination of the cardiovascular system.

As has been stated above, it is possible that many of the normal or borderline cases did not belong

TABLE 1. *Electrocardiographic Findings among Patients with Diphtheria.*

| ELECTROCARDIOGRAM | NO. OF CASES | PERCENTAGE |
|---|---|---|
| Normal | 17 | 18.2 |
| Borderline | 15 | 16.3 |
| Abnormal | 61 | 65.5 |
| Grade 1 changes | 40 | 65.5 |
| Grade 2 changes | 7 | 11.4 |
| Grade 3 changes | 5 | 8.5 |
| Grade 4 changes | 9 | 14.6 |

in these groups because they had only the minimum of five records. That some patients may escape detectable myocarditis is indicated, however, by the fact that thirteen to fifteen tracings in each

by Gore.[5] The essential features are muscle degeneration and cellular infiltration in the early and diffuse fibrosis with loss of muscle fibers in the later stages. Progressive fibrosis begins after the third week.[6] Clinicopathological correlation in our cases revealed the following facts. There were no deaths in the group with normal or borderline records.

TABLE 2. *Incidence of Abnormal Electrocardiographic Tracings.*

| ABNORMALITY | SINGLE | COMBINED |
|---|---|---|
| Prolonged PR interval | 1 | 7 |
| Auriculoventricular dissociation | 0 | 4 |
| Abnormal ST-T | 12 | 17 |
| Abnormal T wave | 15 | 10 |
| Aberration of QRS complex | 0 | 4 |
| Bundle-branch block | 0 | 3 |
| Right-axis deviation | 0 | 4 |
| Frequent ectopic beats | 0 | 10 |
| Auricular | 0 | 5 |
| Ventricular | 0 | 5 |
| Prolonged QT interval | 3 | 6 |
| Abnormal P wave | 0 | 5 |
| Ventricular tachycardia | 1 | 5 |
| Auriculoventricular nodal rhythm | 0 | 6 |
| Auricular flutter | 0 | 1 |
| Auricular fibrillation | 0 | 1 |
| Auricular standstill | 0 | 2 |
| Unidentified rhythm | 0 | 2 |

In those with Grade 1 changes there were 2 deaths, only 1 of which came to autopsy. This patient died of pneumonia due to *Klebsiella pneumoniae* fourteen days after having become ill with diphtheria; autopsy revealed only slight to moderate myocarditis. One death occurred among the patients showing Grade 2 abnormalities. This patient expired on the fourth day of a severe tracheobronchial diphtheria, and autopsy revealed no significant findings in the heart. It is possible that the electrocardiographic findings were due to anoxia and tachycardia or that anatomic changes had not had time to develop. There were 2 deaths among the patients with Grade 3 changes — 1 on the forty-first, and the other on the forty-ninth day of the disease. Both patients showed marked fibrosis of the myocardium at autopsy. The electrocardiograms of the patient who died on the forty-ninth day are shown in Figure 3. Autopsies were performed in 6 of the 8 fatal cases classified as Grade 4. All showed a high degree of myocardial damage, either acute degenerative or fibrotic, depending upon the duration of the illness.

The view that diphtheritic myocarditis may give rise to difficulty years after recovery has been expressed[5, 6] and denied.[7] The demonstration of marked changes in the heart muscles in fatal cases makes it difficult to escape the conclusion that patients who do not die but who have electrocardiographic abnormalities of relatively the same degree as some of those who expire have lost a fair portion of their myocardium. Even if, for the sake of discussion, the minor degrees of departure from the normal are considered to be due to reversible processes (the one autopsy in the Grade 1 group refutes this), and if the patients that make up Grade 4 are given a hopeless prognosis for survival past the acute stage of the disease, there still remain the Grade 2 and 3 groups, over three fourths of whom live. Pathological examination of the fatal cases in Grades 3 and 4 revealed severe cardiac damage. Reversibility of the electrocardiographic changes cannot be considered as indicating a return to normal of the myocardium. Figure 4 presents the records of a patient who died of bronchopneumonia on the forty-seventh day of diphtheria. The electrocardiogram taken just before death showed reversion toward normal, and yet at autopsy there was a severe degree of myocardial fibrosis. Despite the marked destruction of muscle fibers the abnormalities had decreased from Grade 4 with complete auriculoventricular block to Grade 2, or perhaps even Grade 1, at the time of death.

Although the evidence indicates that recovery is complete enough in the young patient, it seems illogical to assume that such hearts have a normal reserve for later life, should hypertension or coronary-artery disease make its appearance. The fifteen-year to twenty-year follow-up study of 100 cases reported by Thompson, Golden and White[7] has the objection that the subjects, ranging in age from sixteen to forty-six years, were still young. The obvious drawback in older persons is, of course, that any abnormality may be attributed to coronary-artery disease alone.

TABLE 3. *Relation of Age to Electrocardiographic Abnormalities.*

| Electrocardiogram | Average Age | Range* |
|---|---|---|
| | yr. | yr. |
| Normal | 11.3 | 3–30 |
| Borderline | 12.8 | 3–33 |
| Abnormal | 27.4 | 3–72 |
| Grade 1 | 30.3 | 4–65 |
| Grade 2 | 25.9 | 5–72 |
| Grade 3 | 21.2 | 3–57 |
| Grade 4 | 19.5 | 3–65 |

*Of these patients, 64.3 per cent were below twenty years of age and 35.7 per cent were over twenty years of age.

TABLE 4. *Average Delay before Treatment.*

| Electrocardiogram | Average Delay |
|---|---|
| | days |
| Normal | 4.0 |
| Borderline | 3.8 |
| Abnormal | 5.2 |
| Grade 1 | 4.8 |
| Grade 2 | 4.4 |
| Grade 3 | 4.5 |
| Grade 4 | 7.6 |

TABLE 5. *Types of Organism in Relation to Electrocardiograms.*

| Electrocardiogram | Mitis Type | Gravis Type | No Type |
|---|---|---|---|
| | % | % | % |
| Normal | 52.9 | 47.1 | 0 |
| Borderline | 53.3 | 13.4 | 33.3 |
| Abnormal | 47.5 | 44.2 | 8.3 |
| Grade 1 | 50.0 | 42.5 | 7.5 |
| Grade 2 | 71.4 | 28.6 | 0.0 |
| Grade 3 | 40.0 | 40.0 | 20.0 |
| Grade 4 | 22.2 | 66.6 | 11.2 |

TABLE 6. *Mortality.*

| Electrocardiogram | No. of Cases | Deaths | Mortality |
|---|---|---|---|
| | | | % |
| Normal | 17 | 0 | — |
| Borderline | 15 | 0 | — |
| Abnormal | 61 | 13 | 14.4 |
| Grade 1 | 40 | 2 | 5.0 |
| Grade 2 | 7 | 1 | 14.0 |
| Grade 3 | 5 | 2 | 40.0 |
| Grade 4 | 9 | 8 | 78.0 |

The fact that the electrocardiogram returns to normal despite loss of muscle substance and fibrosis is a good demonstration, if any more are necessary, of the limitations of the method.

The management of diphtheritic myocarditis revolves mainly about constant and skilled nursing care and maximum rest of the heart. Both quinidine and digitalis have theoretical disadvantages, and their place in the therapy of this disease is not clearly defined. The length of time for which the patient should remain completely inactive is a controversial point. Some clinicians believe that bed rest should be continued until the electrocardiogram has become normal again. Since this may require four to six months or longer, it seems unnecessary to insist on rest in bed for a long period particularly since antitoxin and penicillin rid the patient of the injurious agent rapidly and scar formation in the myocardium is usually well established after the third week.[5] In cases in which the electrocardiographic abnormalities have not disappeared completely, it is probably wise to prohibit severe or prolonged effort for several months.

## Summary

Of 93 patients with diphtheria who had had at least 5 electrocardiograms during the course of the disease, 61 showed abnormal tracings. The remainder were about equally divided between equivocal or borderline changes and normal records.

The degree of abnormality was classified as Grade 1 through 4. Grade 1 changes were found in 40, Grade 2 in 7, Grade 3 in 5, and Grade 4 in 9 patients.

Although the mortality rose sharply with increasing degrees of abnormality, the pathological data available indicated that the anatomic lesions in the heart varied quantitatively rather than qualitatively and that even the lesser degrees of electrocardiographic change were associated with irreversible myocardial lesions.

Neither the type of organism nor delay in antitoxin therapy appeared of any importance in determining the development or degree of electrocardiographic abnormality. The determining factors appeared to be the extent and severity of the local diphtheritic lesion.

Information obtained from autopsied cases showing all types and degrees of normal electrocardiographic patterns indicated that recovery is probably associated with loss of muscle substance and is, therefore, never complete. This apparently holds true even in the face of a return of the electrocardiogram to normal.

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# THE TREATMENT OF RUPTURED LIVER WITH ABSORBABLE HEMOSTATICS*

## Report of Three Cases

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SURGERY of the liver has lagged behind surgical operations on the other abdominal viscera, mainly because of the difficulty of controlling hemorrhage. However, with the recent development of absorbable hemostatic substances in the form of sponges and packs, control of hemorrhage from the liver can be obtained. The purpose of this paper is to present 3 cases of traumatic rupture of the liver in which hemorrhage was controlled with oxycel and gelfoam.

### HISTORICAL REVIEW

In 1888 Langenbuch,[1] with mass ligatures, controlled severe liver hemorrhage following partial resection.

Kousnetzoff and Penski,[2] in 1896, devised a special needle for liver suture. The needle was large, curved, wedge-shaped and blunt tipped. It was passed through the liver with a continuous suture. The suture was subsequently cut up into single mattress sutures and tied. If any large vessels continued to bleed from the cut liver surface they were circumstitched and ligated.

Ceccherelli and Bianchi,[3] in 1894, reported on the use of decalcified bone plates in controlling hemorrhage from the liver. They placed the bone plates on the upper and lower surfaces of the liver and secured them with through-and-through sutures. In a similar manner, Payer used magnesium plates, and Segale ivory rods.[4]

Terrier and Auvray,[5] in 1898, used a continuous-chain-suture technic for hepatic hemostasis, with good results.

In 1902 Beck[6] employed a Nélaton rubber catheter for elastic compression around the cut surface of the liver, together with iodoform gauze as a tampon. The catheter and gauze were brought out through the abdominal wound and removed in four to six days. Later, in the same year, he reported the use of split bands of abdominal wall consisting of fascia, peritoneum and muscle, which were attached to the abdominal wall at one end, the other being used as suture material.

Kocher,[7] in 1902, applied crushing stomach clamps to the cut liver edge. The clamps were brought out through the abdominal wound and removed in forty-eight hours.

In 1905, Cullen[8, 9] used an overlapping-mattress-suture technic with a modified Kousnetzoff needle for controlling hepatic hemorrhage.

Gillette[10] passed five or six sutures of catgut through the entire liver substance, brought them through the chest wall around a rib and tied the sutures on the skin. In 1905 he reported 2 such cases with recovery.

Boljarski,[11] in 1910, used isolated omentum and catgut sutures for control of liver bleeding.

Cushing[12] used striated muscle in neurosurgery as a hemostatic plug and later applied it to liver biopsies, reporting the results in 1911. Striated muscle controlled hemorrhage because thrombokinase liberated by the damaged muscle aided in blood clotting and also the muscle plug by its bulk caused hemostatic compression of the liver sinuses.

In 1915 Grey[13] used sheep's fibrin in small blocks for hemostasis, and Harvey, in 1918,[14] used beef fibrin in small sheets for similar purposes.

Seegers and his co-workers[15, 16] discovered thrombin in 1938 and used it as a hemostatic agent in human beings and animals in the following year.

Ingraham et al.,[17-21] in 1944, used human fibrinogen foam and fibrin foam for hemostasis in neurosurgery and showed the value of these substances in general surgery. They found these products absorbable, nonirritating and more effective in combination with thrombin.

In 1943 Frantz[22] employed oxidized cellulose (oxycel) to arrest hemorrhage from brain, liver, kidney and spleen in animals. The oxidized cellulose was prepared from gauze or cotton and subjected to an oxidation process, which produced cellulosic acid. Hemostasis was a result of the action of this acid, and no advantage was obtained by the use of thrombin with oxycel because thrombin became inactive in an acid medium. The oxycel turned black on contact with blood and was completely absorbed in three or four weeks. It was probably absorbed by phagocytosis and by dissolution as small particles into the blood stream, which were excreted subsequently by the kidneys. Tissue reaction to the oxycel was minimal.[22-25]

Light and Prentice,[26, 27] in 1945, used a gelatin sponge (gelfoam) for hemostasis in surgery. The gelatin sponge was made from ordinary commercial gelatin by the introduction of air into a gelatin solution to obtain a porosity. This sponge was then heated in an oven until dry. The hemostatic

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action of the gelatin sponge was twofold: it acted as a tampon and also liberated thromboplastin from damaged platelets that entered its foamy structure and became traumatized by contact with the walls of its interstices. Gelfoam was hemostatic when used with or without thrombin and was absorbed in fifteen to twenty-four days with minimal tissue reaction.

Levitski[28] chose a hemostol plug for hemostasis. The hemostol plug was made from relatively fresh coagulated human plasma. He used 100 parts of citrated plasma from blood three to five days old and added 5 parts of calcium chloride to coagulate the plasma. The coagulated plasma was transferred to a sponge, and the serum squeezed out of it. The hemostol plug was inserted into the liver wound for three to five minutes, after which hemostasis and adherence took place. This plug of coagulated human plasma was completely absorbed, and the tissue reaction to it negligible.

In 1946, Lowry[29] used synthetic adhesive tape in treating wounds of the liver. After resecting sections of rabbit livers, he applied two strips of Scotch tape, in the form of an envelope, to the liver. The entrapped clot acted as a plug and controlled the hemorrhage. Small localized encapsulated abscesses or caseous residues surrounded by fibrous tissue were usually found at the end of a month of such treatment.

Jenkins,[30, 31] in 1947, applied gelfoam by a blanket technic to control wounds from the liver in animals; he also applied it to the aorta by a cuff technic and to the vena cava and the heart by a patch technic.

## Incidence

Thöle[32] collected 752 cases of liver injury and found that a third were due to internal injuries (patient run over by wheel, blow to abdomen and so forth), whereas two thirds were penetrating injuries, such as stab and gunshot wounds. Of Krieg's[33] 60 cases, 83 per cent were of the penetrating type, and only 17 per cent of the subcutaneous type. Anderson[34] found that the liver was injured in 10 per cent of all open wounds of the abdomen, and in 19.5 per cent of internal abdominal injuries. During World War II, Fox[35] reviewed 270 thoracoabdominal wounds in an American combat hospital in Italy and reported 27 per cent involvement of the liver. The liver was drained in 18 per cent, packed with gauze in 9.7 per cent, sutured in 2.8 per cent and packed with muscle in 1.6 per cent. Of these cases, subphrenic abscesses developed in 6 per cent, intrahepatic abscesses in 1 per cent, subhepatic abscesses in 4 per cent and biliary peritonitis in 0.7 per cent.

## Mortality

Among 829 patients with wounds of the liver in World War II, Madding[36] reported a mortality of 27 per cent, regardless of the type of treatment. According to Boljarski,[37] the mortality for penetrating wounds was 30 per cent, whereas that for internal injuries was 88 per cent.

Thöle[32] found the operative mortality in penetrating and internal injuries of the liver to be 39 per cent during the first six hours after injury. 50 per cent after six to twelve hours, 67 per cent after twelve to twenty-four hours and 86 per cent after twenty-four hours.

Boljarski's[37] figures likewise indicate the value of early operation. He reported an operative mortality of 15 per cent during the first three hours after injury and one of 50 per cent twenty-four hours after injury.

Death during the first seventy-two hours after hepatic trauma is usually due to hemorrhage and shock. After the fourth day, it is due to biliary septic peritonitis. Hemorrhage from liver rupture or penetration is severe because the hepatic veins are thin walled, contain very little elastic tissue and have no valves. Bleeding is also prolonged because of the massaging effect of the diaphragm and the admixture of bile with blood, which delays clotting.

## Amount of Liver Necessary for Life

Mann[38] (1927) removed as much as 50 per cent of liver tissue in animals without any serious impairment of liver function. He also demonstrated that liver tissue has remarkable powers of regeneration and recuperation. Ireneus and Puestow,[39] in 1944 removed as much as 90 per cent of liver tissue in dogs in successive intervals with survival. They also showed that the functional reserve of liver is unimpaired after massive blood loss from partially hepatectomized animals. In 1947 Martin[40] disclosed that in dogs the usual functional liver tests, such as bromsulfalein excretion, galactose tolerance, prothrombin time and alkaline phosphatase are not affected to any appreciable extent after massive trauma to the liver when as much as 50 per cent of the liver was damaged.

## Classification of Liver Trauma

Liver trauma may be classified according to cause or effect. The classifications of Vance[41] are as follows: percutaneous or penetrating (stab or gunshot wounds); and internal or nonpenetrating (blow or wheel compressing abdomen). Moynihan[42] lists the following as the results of pathologic conditions: rupture of the liver, with laceration of Glisson's capsule; subcapsular hemorrhage; and central rupture, with hematoma formation and subsequent development of an abscess or cyst.

## Case Reports

Case 1 (B.C.H. 1258525). D.L., a 19-year-old boy, was admitted to the hospital on August 26, 1947, with a history of having fallen from a horse-drawn wagon, whose wheels ran over his chest. The patient complained of pain in the right lower lateral portion of the chest wall, right shoulder and right upper quadrant.

Physical examination showed that the patient was in shock, but alert and responsive. There was dullness with decreased breath sounds at the right base, and the ninth, tenth and eleventh ribs in the right midaxillary line were tender. The heart sounds were feeble and rapid. The right upper quadrant was tender but nonspastic. There was slight tenderness in both lower quadrants. The liver edge was tender but not displaced below the right costal margin.

The blood pressure was 40/30, the pulse 125, and the respirations 50.

The patient was given 1500 cc. of 5 per cent glucose in physiologic saline solution, 500 cc. of whole blood and 2 units of plasma; the blood pressure rose to 110/80 1 hour after admission. Gas-gangrene and tetanus antitoxin was also given prophylactically. X-ray examination of the chest and abdomen was negative for pneumoperitoneum, pneumothorax and hemothorax. The red-cell count was 3,500,000, with a hemoglobin of 7.5 gm. and a white-cell count of 25,000. The urine was normal. Abdominal exploration was decided upon, the preoperative diagnosis being rupture of the liver.

Under spinal anesthesia the peritoneal cavity was entered, and at least 1500 cc. of free blood was aspirated. A large, 10-cm., stellate-shaped laceration was found on the dome of the right lobe of the liver. The lacerated liver was packed with two squares of gelfoam and three strips of oxycel, and hemostasis was obtained. Two drains were placed in the peritoneal cavity, one in the subhepatic and the other in the suprahepatic space. The abdomen was closed in layers with No. 1 chromic catgut and No. 28 steel-wire stay sutures.

The patient was placed on gastric suction for 3 days. An x-ray film of the chest on the 4th postoperative day revealed fluid in the lower right pleural cavity. On the 5th postoperative day the drains were removed, and he was allowed out of bed. The right side of the chest was tapped, and 1000 cc. of serosanguineous fluid was obtained on the 15th postoperative day. A repeated chest tap 4 days later yielded 150 cc. of foul-smelling pus, from which a hemolytic *Staphylococcus aureus* and *Proteus vulgaris* were cultured.

A diagnosis of subphrenic abscess was made, and on the seventeenth day a thoracotomy was performed, 200 cc. of pus being evacuated from the right subphrenic space. Culture of the thoracotomy fluid revealed *Pseudomonas aeruginosa* and enterococci. The thoracotomy drain was removed 1 week later. The patient received penicillin for approximately 1½ months and was discharged 50 days after admission with a slight amount of purulent drainage from the chest wound.

Case 2 (B.C.H.1267897). B. M., a 26-year-old man, was admitted to the hospital on November 25, 1947, with a history of having been struck by an automobile and dragged approximately 50 feet. He complained of moderately severe right-sided chest pain. This pain was aggravated by deep breathing and was relieved when the patient lay on the right side.

Physical examination showed a conscious and co-operative man who was in shock. There was decreased expansion of the right lung, but the lung fields were clear to percussion and auscultation. The heart sounds were distant and thready. Both upper abdominal quadrants were tender, but there was no muscle spasm. Intestinal peristalsis was audible.

The blood pressure was 60/0, the radial pulse was absent, and the respirations were 36.

X-ray examination revealed no pneumothorax, hemothorax or pneumoperitoneum. Examination of the blood disclosed a red-cell count of 4,010,000, with a hemoglobin of 13.5 gm., and a white-cell count of 20,000. The urine was normal. Plasma, whole blood and gas-gangrene and tetanus antitoxin were given. The blood pressure rose to 100/60. The preoperative diagnosis was rupture of the liver. Abdominal exploration was decided upon.

An upper right-rectus-muscle-splitting incision was made in the abdomen under spinal anesthesia, and whole blood was transfused into the veins of an arm and leg simultaneously. The peritoneum was opened, and about 2 liters of free blood was found in the peritoneal cavity and aspirated. Large jagged lacerations were found in the domes of the right and left lobes of the liver. Oxycel gauze was packed into these lacerations and sutured loosely to the liver with No. 0 chromic catgut. The abdominal wall was closed in layers with No. 1 chromic catgut and four silk stay sutures without drainage.

The patient remained on intestinal suction for 5 days and was sustained on 3000 cc. of fluids administered intravenously each day. The patient was able to walk on the 2nd postoperative day. X-ray examination showed some haziness present in the left-lower-lung field on the day after operation, but this rapidly cleared by the 10th day. All sutures were removed on the 11th postoperative day. The patient received penicillin intramuscularly for 12 days and was discharged as improved 15 days after admission.

Case 3 (B.C.H. 1276872). N. S., a 27-year-old Negress, was admitted to the hospital on February 27, 1948, after having been struck by an automobile. The patient was in shock and complained of severe constant pains in the right shoulder, right lateral portion of the chest and right upper quadrant. These pains were aggravated by breathing.

Physical examination showed the patient to be alert, oriented and co-operative but apprehensive. The skin was cold, clammy and ashen gray. There was splinting of the right side of the chest. The right leaf of the diaphragm was elevated, and the right tenth, eleventh and twelfth ribs in the midaxillary line were tender. The chest revealed no pneumothorax or hemothorax. The heart sounds were weak and rapid. The liver edge was felt 2 fingerbreadths below the right costal margin and was very tender. There was marked tenderness in the right upper quadrant with bilateral rectus-muscle spasm. Intestinal peristalsis was absent. At the junction of the middle and upper thirds of the right leg there was a bony deformity with crepitation, indicating a fracture site.

The blood pressure was 60/40, the pulse 120 to 150, and the respirations 50.

Examination of the blood disclosed a red-cell count of 3,470,000, with a hemoglobin of 10.5 gm., and a white-cell count of 22,150. A specimen of urine was negative for blood.

The patient was given 1500 cc. of 5 per cent glucose in physiologic saline solution, 300 cc. of plasma and 500 cc. of whole blood. The blood pressure rose to 110/70, and the pulse dropped to 112. The right lower quadrant was tapped with a spinal needle, and free blood was obtained from the peritoneal cavity. Because of the patient's response to shock therapy 7 hours after admission, abdominal exploration was decided upon, the preoperative diagnosis being rupture of the liver and questionable rupture of a hollow viscus.

Under spinal anesthesia, while blood was being transfused into one arm and leg, an upper-right-rectus-muscle-splitting incision was made in the abdomen. When the peritoneum was incised, about 1 liter of blood poured out from the peritoneal cavity. The blood was sucked out from the liver and a 12.7-cm. stellate laceration was palpated on the dome of the right lobe of the liver. The stellate laceration was sponged out with dry gauze and packed with four strips of oxycel gauze and held with moderate pressure until hemostasis occurred. The liver capsule was subsequently sutured to the inferior surface of the diaphragm and a portion of the anterior abdominal wall to prevent a suction effect of the diaphragm on the liver. The abdomen was closed without drainage, No. 1 chromic catgut being used as suture material and No. 28 steel wire for stays.

On the third postoperative day the fractured right lower leg was reduced under spinal anesthesia and set in a mid-thigh-to-toes plaster cast. On the 5th postoperative day chest films revealed development of fluid in the right-lower-lung field. The skin sutures and steel stays were removed on the 8th and 11th days after operation. The right side of the chest was tapped on the 26th postoperative day, and serous fluid obtained. Culture of this fluid was negative. Repeated check of x-ray films of the chest revealed clearing of the fluid in the right base. Two months after operation, the cast on the right leg was removed, and a brace applied. The patient received penicillin intramuscularly for 6½ weeks and was ambulatory after the 11th postoperative day. She was discharged 67 days after admission as improved.

## Discussion

The use of absorbable hemostatics in liver surgery is a new procedure. Very little is known of their application to human beings, since most of the literature deals with their use in animals. The cases presented above may be of significance in

showing the value of absorbable hemostatics in ruptured livers in human beings. In all cases relatively complete hemostasis was obtained three to five minutes after the laceration had been packed with oxycel and gelfoam and gentle pressure applied. No delayed secondary liver hemorrhage ensued postoperatively. Pulmonary complications such as atelectasis and hydrothorax were common sequelae, and thoracentesis was frequently resorted to. In Case 1, in which the peritoneal cavity was drained, a temporary biliary fistula and subhepatic abscess developed, and thoracotomy with rib resection was required. Postoperative biliary peritonitis or fistula never developed when the abdomen was closed without drainage. Hence, primary closure of the abdomen without drainage is advocated instead of that with drainage.

These cases present relatively simple technics of obtaining hemostasis in bleeding livers. The patient in Case 1 was treated by simple packing and compression of the lacerated liver with oxycel and gelfoam, the patient in Case 2 by loose suture of the oxycel to the liver capsule, and the patient in Case 3 by packing of the lacerated liver with oxycel and suturing of the capsule of the liver to the diaphragm and abdominal wall to prevent the suction effect of the diaphragm on the liver. All three of these methods proved satisfactory in the control of hepatic hemorrhage.

It may be added that though the abdominal approach was used in these cases, some surgeons would choose the thoracic method because of the greater exposure of the dome of the liver obtained. However, when there is trauma to an abdomen, a hollow organ as well as a solid organ may be ruptured. To differentiate hollow-organ perforation and solid-organ rupture is often difficult, and the two frequently occur simultaneously. Hence, if jejunum, ileum or colon is perforated and the liver ruptured, an abdominal approach will give better exposure to these structures situated in the middle or lower portion of the abdomen. If greater exposure of the superior surface of the liver is required, a combined abdominothoracic incision is indicated.

## Summary

A brief history of control of liver hemorrhage in surgery is presented, and 3 cases of traumatic rupture of the liver in human beings successfully treated with oxycel and gelfoam are reported.

The treatment recommended for large or jagged lacerations of the liver is packing of the laceration with absorbable hemostatic sponges (gelfoam, oxycel, fibrin foam or fibrinogen foam).

These hemostatic packs may be held in place by simple pressure, suture to the liver capsule or suture of the liver capsule to the diaphragm and abdominal wall.

Closure of the abdomen without drainage is advocated because it lessens the chance of external infection along the drainage pathway.

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# MEDICAL PROGRESS

## THORACIC SURGERY

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THIS report concerns the following aspects of advances in thoracic surgery: anatomy of the lung; physiologic considerations; chest injuries; cancer of the lung; tuberculosis; coccidioidomycosis; suppurative disease; bronchiectasis; the esophagus; congenital atresia; and miscellaneous considerations.

### Anatomy of the Lung

In recent years, significant progress has been made in precise descriptive anatomy of the lung. Advances have been made along two broad lines: accurate topographic description of the bronchopulmonary segment; and reduction of the complexities of bronchovascular anatomy to a reasonable schedule.

Although there is quite general agreement among anatomists and surgeons regarding the disposition of the segments, there is less agreement about their terminology. Boyden,[1] has accepted the nomenclature of Jackson and Huber[2] as the most accurate and simplified currently available. This terminology is based upon the position of the segment within the lobe, rather than upon its relation to the chest wall or adjacent structures. British authors — Brock,[3] Foster-Carter,[4] Appleton[5] and others — have inclined toward the latter view. Brock has published an extremely useful volume on the anatomy of the bronchial tree, which, together with the papers of Jackson and Huber (1943), and Boyden (1945), covers the subject admirably. Boyden[6–10] has also embarked upon a thorough quantitative study of bronchial variations and related bronchovascular patterns.

By way of summary the following schedule of the bronchopulmonary segments is appended, Huber's terminology, Boyden's system of enumeration and, parenthetically, Brock's nomenclature being used:

| Right Upper Lobe | Left Upper Lobe |
|---|---|
| 1. Apical (*apical*) | 1 + 3. Apical-posterior (*apical-subapical*) |
| 2. Anterior (*pectoral*) | 2. Anterior (*pectoral*) |
| 3. Posterior (*subapical*) | 4. Superior lingular |
| | 5. Inferior lingular |

| Right Middle Lobe |
|---|
| 4. Lateral (*lateral*) |
| 5. Medial (*medial*) |

| Right Lower Lobe | Left Lower Lobe |
|---|---|
| 6. Superior (*apical*) | 6. Superior (*apical*) |
| 7. Medial basal (*cardiac*) | 7 + 8. Anteromedial basal (*anterior basal*) |
| 8. Anterior basal (*anterior basal*) | 9. Lateral basal (*middle basal*) |
| 9. Lateral basal (*middle basal*) | 10. Posterior basal (*posterior basal*) |
| 10. Posterior basal (*posterior basal*) | |

As technical experience with excision of the lung has increased, the need for precise knowledge of the associated vascular arrangement within the lung has become apparent. The surgical contributions of Churchill and Belsey,[11] Kent and Blades[12, 13] and Miscall and Cornell[14] are well known. Recently, Overholt[15] has discussed the subject in surgical detail relative to segmental resection. Regarding bronchovascular anatomy, the studies of Boyden and his associates[6, 7] and also of Appleton[16] are of great importance. Complex by necessity, they are available reference material for future clinical developments. In Boyden's work the prevailing bronchovascular pattern and common variations therefrom are discussed in detail and suitably illustrated. The segmental nature of the pulmonary arterial supply, corresponding in general to the bronchial segments, but with considerable variation at the level of the hilus, has been confirmed. The veins, on the other hand, have been shown to be intersegmental. The major clinical application of these studies has been in the technics of segmental resection.

Liebow et al.[17] have reported an excellent and relatively simple method of preparing lungs by the injection of various colored plastics. Particularly in the study of abnormalities of bronchial-artery supply, as well as the production of exquisite anatomic specimens, the method should be of great value. Cauldwell and his associates[18] have described the complexities of the bronchial-artery supply on the basis of 150 cadaver dissections. There is obviously a rich collateral circulation at the level of the lobar bronchus, and great variation in both origin and distribution of the main bronchial-artery trunks.

### Physiologic Considerations

The measurement of pulmonary function, either total or of each lung separately, continues to have its greatest clinical application in collapse therapy.

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It is the consensus of those working in this field that in only a small group of patients are quantitative tests of pulmonary function, particularly divided functions, necessary, but that in the borderline cases they are of tremendous practical help.

Cournand and Richards[19] have reviewed the subject of pulmonary insufficiency and adapted many of the previous laboratory studies to the purposes of clinical medicine. Drawing on their own experience and that of others, they have distinguished between the ventilatory and respiratory aspects of pulmonary function with symptoms of dyspnea and cyanosis respectively. Dyspnea is usually dependent upon a mechanical fault, which in turn may result in a physicochemical imbalance. The two factors may be combined, and they may or may not have cardiocirculatory complications. In the study of ventilatory insufficiency, Cournand and Richards have recommended the following: maximum breathing capacity, — that is, maximum voluntary ventilation per unit of time (normally, 154 liters per minute for male and 100 liters per minute for female patients); breathing requirement; and breathing reserve, which equals maximum breathing capacity minus the actual ventilation per minute in any given physical state. The authors have considered the ratio of breathing reserve to maximum breathing capacity a useful index of pulmonary function that could be correlated with observed dyspnea in their cases. Their own experience and that of others suggested that a decrease in arterial oxygen saturation and a decrease in the rate of oxygen removal from the inspired air (ventilatory equivalent) were the most useful indicators of respiratory insufficiency. In a group of 31 thoracoplasty patients, it was apparent that by far the greater part of the subject's loss of pulmonary function existed prior to operation. Of some practical interest was the fact that when the reserve was less than 85 per cent of maximum breathing capacity, a difficult postoperative course was likely. In a review of the published experience of many authors,[20–23] it is apparent that maximum breathing capacity has been the clinical cornerstone of external spirometric methods, replacing the time-honored but less reliable vital capacity.

Bronchospirometry, or internal spirometry, has also had extensive clinical application, chiefly in the field of collapse therapy.[24, 25] Here, the limitations imposed by "stenosis breathing" have rendered interpretation of results difficult. Norris, Long and Oppenheimer[26] have recently attempted to minimize this factor by using a single-lumen endobronchial catheter to replace the double-lumen catheter of Zavod[27] or Gebauer,[28] which, in turn, replaced the bronchoscopic method of Jacobeus. The differential uptake of oxygen, usually in conjunction with the ventilatory function of each lung has been the basis of most studies. The analogy to split renal-function studies is obvious, but the validity of interpretation is not so clear.

Vaccarezza et al.[29] have recently described 15 cases of marked discrepancy between clinicoradiologic and bronchospirometric findings. The difficulties of determining function on the basis of the x-ray film are obvious, but it is of interest that the authors accept the laboratory data as their frame of reference when it is apparent, on review of the protocols submitted, that artifacts, particularly those arising from bronchial secretions blocking the airway, may have greatly modified results. In so complex a function as respiration, quantitative measurements must be interpreted with caution. Wright and Woodruff[30] have discussed the complexities of bronchospirometry and have demonstrated many of the variables involved in its clinical application. Wright[31] has recently reported a case of chronic tuberculous empyema in which, after decortication and expansion of the lung, there was only slight increase in ventilation of that lung, and the development of incomplete arterial oxygen saturation. This case is of interest as a qualitative measure of physiologic loss to offset a radiologic gain.

Pulmonary edema has been the subject of a monograph by Drinker,[32] who defends the thesis that pulmonary edema and related phenomena depend more upon alterations and permeability of lung capillaries than upon complicated pressure relations in the pulmonary circulation. Anoxia, a cause of increased capillary permeability throughout the body, is considered to be equally effective in the lungs, but the capillary membrane is dependent upon the oxygen of the alveolar air rather than upon that in the blood stream. By blocking the alveoli, "anoxia begets anoxia" as, in shallow breathing, anoxemia, by depressing the respiratory center, leads to further anoxemia.

Eaton[33] has approached the problem of pulmonary edema consequent upon acute blood loss. He had noted an increase in pulmonary lymph flow and histologic evidence of edema in dogs suffering acute loss of 25 per cent of blood volume from the femoral artery. Experimentally, a disproportionate rise of pulmonary-artery pressure seemed to be a significant change in a cycle of progressive circulatory imbalance, which included low systemic arterial pressure and elevated peripheral venous pressure. This fact was interpreted as evidence of an obstruction to normal circulation existing in the lung or the left side of the heart, or both. From this point of departure, efforts were made to measure "pulmonary moisture" under experimental conditions of hemorrhage and replacement. It became obvious that replacement by intravenous saline solution of blood lost led to more consistent and greater increases in "pulmonary moisture" than did replacement by blood. The clinical application of this is apparent.

Collateral ventilation has been restudied by Baarsma and Dirken[34] spirometrically, confirming, in rabbits, the previous work of Van Allen and his associates in dogs. The Dutch authors have also extended their studies to man.[35] In a limited series of observations, using an occluding catheter with an inflatable cuff, no collateral ventilation was apparent on occlusion of a lobar bronchus, but definite collateral ventilation was demonstrated upon occlusion of a segmental bronchus in the lower lobe. Lindskog (who contributed much to the early studies in this field) and Alley[36] have recently observed in dogs that the intravenous administration of histamine results in the abrupt cessation of collateral respiration that persists for variable periods of minutes. This effect is abolished by prior administration of benadryl. It seems important to extend these observations to other agents in common clinical use and to changes in the physiologic state of the patient.

Perhaps the physiologic advances that have the greatest bearing on thoracic surgery have been consequent upon the recent development of the cardiac-catheterization technic. First introduced by Forssman in 1929, much of its recent development is attributable to the efforts of Cournand and his associates.[37] Furthermore, effective teamwork between physiologist and surgeon has been particularly apparent in the combined efforts of Bing et al.[38] on the one hand and Blalock and his coworkers on the other. McMichael,[39] in Great Britain, and Dexter and his associates,[40] in Boston, have also contributed significantly to the subject. The use of the method is by no means limited to these few centers, and the literature on the subject is extensive.

The earliest of recent efforts were directed toward accurate measurement of cardiac output utilizing the Fick principle, which, stated simply, is that cardiac output equals oxygen intake divided by arteriovenous oxygen difference. Heretofore, inaccuracies had arisen from the inability to obtain true mixed venous blood. By sampling directly from the auricle, the ventricle or the pulmonary artery this source of inaccuracy could be obviated.[37] By further development of the Fick principle, direction and amount of flow in abnormal circulatory shunts could be estimated.[38, 40] By study of pressure changes in the ventricles, pulmonary arteries, peripheral arteries and other portions of the circulatory system, more accurate study of hemodynamics is now possible, and precision methods of the experimental laboratory can be applied to clinical problems. Changes in the pulmonary circulation under physiologic and pathologic conditions are at present under the closest scrutiny.[38, 40, 41–43]

Although cardiac catheterization has been a relatively safe procedure, there are hazards attendant upon its use. Cardiac irregularities during catheterization are not uncommon, there is always the hazard of air embolism in the presence of a right to left shunt, and intimal damage though presumably rare, remains a possibility. However, with proper indications, there can be little doubt of the clinical and experimental value of the method.

## Chest Injuries

In the war the principles underlying the management of serious injuries to the chest were tested against a tremendous volume of experience. Many concepts, proved valid after much extensive trial, are directly applicable to the severe chest injuries encountered in civilian practice and in the casualties of heavy industry and high-velocity automobiles.

Churchill[44] has presented, in general terms, the management of thoracic casualties in the military theater to which he was consultant. He has emphasized the importance of distinguishing two phases of chest trauma: the serious disturbance of cardiorespiratory physiology that demands prompt and intelligent treatment; and the problem of infection, which requires fully as intelligent but less urgent attention. More specifically, he suggests, "the urgent physiologic disturbances that attend wounds of the chest can be controlled by needle aspiration of air and blood, aspiration of blood and mucus from the tracheobronchial tree, novocaine injection of intercostal spaces, insertion of a catheter with a flutter valve for pressure pneumothorax, oxygen therapy and transfusions, and débridement of sucking wounds with hemostasis of intercostal vessels and approximation of deep structures of the chest wall to close the pleural opening." In the emergency treatment of such wounds, however, an occlusive dressing of petrolatum gauze and adhesive strapping was not only adequate but also preferable to an airtight closure in that it could act as an escape valve in case a persistent bronchial leak were present.

Of the measures detailed above, some have important application to trauma as seen in civilian life. Significant among these is the use of intercostal block for the relief of pain, as opposed to the time-honored but physiologically unsound, overgenerous use of morphine and tight adhesive strapping. The latter should be reserved for minor rib fractures, and possibly also for a few cases of paradoxical motion of the chest wall resulting from anterior and posterior fractures of the ribs. In such cases, when the paradoxical motion is of an intolerable degree, open operation may be necessary. By permitting the patient to cough effectively and breathe actively, intercostal block is instrumental in maintaining a clear airway so essential to the patient. Some authors, notably Burford and Burbank,[45] on the basis of considerable first-hand experience with thoracic casualties, have argued that the "wet lung of trauma" may depend on more than mechanical interference with the chest bellows.

and partial obstruction of the airway. They have postulated a somatovisceral reflex, accounting, in part at least, for changes in the underlying lung following painful injuries to the chest wall. Experimental support is found in the work of deTakats et al.,[46] who noted, in the dog, bronchial spasm and increased bronchosecretory activity after trauma to the chest wall, as well as after experimental pulmonary embolization and intra-abdominal manipulation. Daniel and Cate[47] have produced "wet lung" in anesthetized dogs by blunt trauma and tangential bullet wounds of the thoracic cage. Effects of this trauma could be intensified by intravenous infusions of saline, which also produced "wet lung" in dogs breathing low concentrations of oxygen. The effects of excision of large portions of the pulmonary sympathetic supply upon the development of generalized "wetness" were not conclusive, but suggested that the condition was, in part, a reflex phenomenon. Interference with respiratory motion and decrease in effective cough have seemed to many to offer adequate explanation of the pulmonary moisture and collapse following thoracic injury, and reason enough to employ intercostal block in their relief.

To render oxygen administration effective, Army technical bulletins[48] have been explicit in recommending the free and prompt use of tracheal suction or bronchoscopic aspiration. Samson and Brewer[49] have recently reviewed their experiences in this regard and outlined practical suggestions to improve inadequate tracheal-bronchial drainage following trauma to the chest. The technics of tracheal aspiration and the importance of forced cough after the airways have been cleared are carefully explained.

One of the definite departures from prewar practice has been in the treatment of hemothorax. On the theoretical ground of controlling continuing bleeding from a lacerated lung, aspiration of blood with air replacement had been recommended. During the war, however, it was found that continuing intrapleural hemorrhage was rarely of pulmonary origin, that prompt re-expansion of the lung was desirable and that prompt needle aspiration of massive hemothorax, the blood obtained being used for autotransfusion if necessary, should be carried out. The use of whole blood in chest wounds, when it is of obvious importance to restore the oxygen-carrying capacity, as well as the volume of circulating blood, was established.

The late effects of intrapleural bleeding with clotted hemothorax or chronic hematoma of the pleural space were responsible for one of the more dramatic surgical developments of the war — namely, pulmonary decortication. Samson and Burford[50] have presented an excellent general review of the subject and have given a detailed account of the technic of operation. They have emphasized the fact that the fundamental lesion is not of the pleura itself but of a false membrane overlying the pleura. The aim of the procedure is early restitution of pulmonary function, and the avoidance of the late, crippling effect of extensive fibrothorax. They, in common with most authors who have written on this subject, limit their procedure chiefly to the visceral pleura and are not concerned with the parietal peel. In the uninfected clotted hemothorax, decortication was carried out four to six weeks after trauma if there appeared, by x-ray examination, to be lateral pulmonary compression of 50 per cent or more, if there were obvious limitations of chest expansion and if there was clinically significant shortness of breath. It was believed that prior to three weeks after injury, the peel was not sufficiently tough to permit satisfactory removal, and that after that time fibrous changes were found in the lung. In cases of infected hemothorax, the time of operation was advanced to about two weeks after trauma. Signs of increasing toxicity, mounting fever or rapid increase in the size of the hemothorax were considered presumptive evidence of infection. In 125 cases in which operation was performed, there were no deaths and no serious sepsis, and less than 25 per cent of patients had residual empyemas, the great majority of which were small and basal in location. The authors estimated that approximately 1500 early decortications had been done in the armed forces with an operative mortality of less than 2 per cent.

Tuttle, Langston and Crowley[51] have also reported essentially similar experiences with early decortication for chronic traumatic hemothorax and have described in detail the pathological changes encountered in this condition. Of 89 cases of uninfected (not grossly infected), and 51 grossly infected hemothoraces, a total of 140 cases, the results were good in 77.1 per cent, fair in 18.6 per cent and poor in 4.3 per cent; there were no deaths. Their criterion for "good" was exacting — namely, that the lung after the operative procedure expanded completely in forty-eight hours. A "fair" result meant that the ultimate result was good, but somewhat delayed. In the cases of infected organizing hemothorax (51 cases), primary healing of the empyema occurred in 49.1 per cent, eventual healing in 45.1 per cent and chronic empyema in 5.8 per cent. Penicillin was not always available during the course of this study and was used in 77 of the 140 patients. It is of interest that all 25 patients who experienced primary closure of the empyema space after decortication received penicillin. Sanger[52] has argued that perhaps the importance of penicillin has been overrated in decortication for empyema, admitting, however, that it has given the surgeon courage to proceed in the presence of severe infection. He believed that the mechanical removal of the culture medium upon which the organisms could grow and the re-expansion of the

incarcerated lung were of more importance than chemotherapy, which, however, seemed to be of greatest effect in preventing invasive infection. As a result it now appears not only possible but also, in many cases, advisable to convert a localizing empyema into a generalized pleural contamination to re-expand the lung, thereby reversing the field completely so far as the classic treatment of empyema is concerned.

One of the casualties of the war has been the sanctity of the diaphragmatic barrier. For many years the transthoracic route to the structures of the upper abdomen has been employed, but not with the zeal and general enthusiasm that is now apparent.[53] It seems reasonable to suppose that the wide experience with thoracoabdominal wounds in the recent conflict has done much to break down the old pattern of thought, which divided the body neatly at the midriff. Space does not permit a review of the many excellent reports of experience in large thoracic centers and general hospitals in the Army and Navy.[54–60] In a sense, these reports are the source material from which broader concepts of the management of serious thoracic injury have been derived.

Blades[61] has recently summarized the opinion of many others that the advances in the treatment of chest injuries during the war were largely the result of judicious timing and selection of surgical procedure rather than technical improvement. In summary of the application to civilian emergencies of lessons learned from the military, he has emphasized the use of whole blood in the treatment of shock; the dangers of excessive use of morphine; the control of chest pain by paravertebral block; the treatment of "traumatic wet lung" by paravertebral block, oxygen and tracheobronchial aspiration; the early aspiration of hemothorax to effect complete re-expansion of the lung and conservation of cardiopulmonary function; and, finally, decortication in cases of clotted hemothorax based on indications established in the war.

## Cancer of the Lung

### *Earlier Diagnosis*

Churchill[62] has recently reviewed the problem of cancer of the lung and re-emphasized the need of earlier diagnosis, pointing out that it is doubtful if more radical treatment can be devised that will materially improve results. The limits of operability — so far as the patient's chance of surviving major surgery are concerned — have been extended, so that resectability rates are steadily being revised upward. It is important to remember, however, that the rates are a measure not only of the individual courage and skill of the operator but also of the process of selection of cases before the patient reaches the surgeon. There is therefore great need for intelligent teamwork between practitioner and expert consultant.

For various reasons, detection by means of survey films shows only moderate promise. Men between forty and sixty, the age group that suffers the highest incidence of pulmonary cancer, are the most difficult to include in any survey. Furthermore, except for the few silent peripheral lesions, x-ray changes are usually dependent upon bronchial encroachment, which produces symptoms sufficient to send the patient to the doctor.

The symptoms of cancer of the lung are well known and need no repetition here, except to recall that they may be so commonplace as to escape the serious attention of the patient or his physician. As many have emphasized, the important points in a review of symptoms are change in cough habits; persistent, unexplained or rationalized x-ray shadow; persistent streaking of the sputum — corresponding to the constant trickle from a gastrointestinal cancer that gives rise to occult blood in the stool; and the cold that "hangs on."

One of the more important recent advances in the diagnosis of cancer of the lung has been the increasing use of cytologic studies of the sputum or of bronchial secretions. Many papers dealing with the technics of such studies are available. As in any precise laboratory maneuver, great attention must be paid to the details of collecting and preparing the material, and considerable mature judgment must be exercised in interpretation of specimens. Although examination of the sputum for tumor cells had been done sporadically for many years, the first widespread and successful clinical application of the method was reported by Dudgeon and Wrigley[63] in 1935. They found 43 positive sputums in 56 cases of proved carcinoma of the lung — that is, false-negative tests in 23 per cent of their cases. In 2 of 102 cases the sputum was reported positive, but these cases were ultimately proved to be of inflammatory nature — false-positive reactions, therefore, in 2 per cent of cases. In 1943 Gowar,[64] at the London Hospital, reported a series of 93 patients suffering from pulmonary disease of whom 63 were proved to have carcinoma. Of these, 36 (57 per cent) had a positive sputum — false-negative reactions, therefore, in 43 per cent. The number of false-positive tests was not stated. Wandall, in 1944,[65] reported extensive experience culled from the hospitals of Copenhagen. One hundred and ninety-three patients with pulmonary disease were studied, 120 of whom were proved to have carcinomas of the respiratory tract, of which 100 were carcinomas of the lung. Of the 120, there were positive sputums in 98 (82 per cent), or 18 per cent false-negative reactions. Of the 193 cases, there were 3.2 per cent false-positive tests in cases of chronic pneumonia and tuberculosis. Wandall's series and those reported above were based on the

histology of fragments in the sputum, with careful study of the characteristics of the individual cells.

More recently, there has been widespread interest in the cytologic study of sputum by the Papanicolaou technic or its modifications. At the recent Quebec meeting of thoracic surgeons, Watson et al.[66] reported their experience in the study of pulmonary neoplastic disease. In 400 cases studied at The Memorial Hospital, 236 patients had carcinoma, and of these, 141 (60 per cent) had positive sputums. False-positive reactions occurred in 4 of an over-all group of 1200 cases. In 3 cases the specimen came from a patient subsequently found to have bronchiectasis, and the confusing cells were probably fragments of papillomatous growths of the bronchial mucosa such as have been previously described.

In 1946 Herbut and Clerf[67] reported 83 cases studied, in which 38 patients had carcinoma — 30 with positive sputums, or 79 per cent positive reactions. No false-positive tests were reported. These authors stressed the desirability of studying bronchial washings obtained at time of bronchoscopy by saline irrigation and aspiration of specific limbs of the bronchial tree, rather than sputum, which is more dilute and whose source is less specific. A preliminary survey of the experience with pulmonary cases at the Massachusetts General Hospital yields the following figures.[68] In a total of 157 cases studied in 1946, 56 patients were shown to have carcinoma of the lung. One hundred and nineteen had sputum studies, with false-negative reactions in 37.9 per cent and false-positive reactions in 6.0 per cent. In 81 cases cytologic examination of bronchial washings was performed, with 56 per cent false-negative and 1.8 per cent false-positive tests. In the following year, 123 cases were studied with either or both methods. Fifty-four patients had cancer. Examinations of the sputum were performed in 74 cases, with 25.7 per cent false-negative and no false-positive reactions. In 60 cases of bronchial aspiration there were false-negative tests in 66.0 per cent and no false-positive tests. Strieder[69] reports the experience at the Boston City and the Massachusetts Memorial Hospitals, as follows: in 170 cases studied bronchoscopically, 48 patients had carcinoma proved histologically, and 6 had unequivocal clinical evidence of carcinoma. Positive smears were obtained in 40, or 74 per cent of the 54 cases. False-positive reactions occurred in 3 cases, or 1.8 per cent. Bronchoscopy was positive in 29 of the 54 cases, or 54 per cent.

A review of the reported experience at large makes it apparent that theoretically and in practice, cytologic examination of the sputum will give a higher percentage of positive results than bronchoscopic biopsy. Added to the other data obtained in a given case, it may be an important bit of evidence, when positive, on which the decision to operate may be based. Particularly in the early and obscure case, it may be of great value in strengthening the surgeon's hand. It is also apparent that the incidence of false-negative reactions is sufficiently high so that a negative examination cannot be strongly considered in ruling out carcinoma — 18 per cent in Wandall's[65] series, 43 per cent in that of Gowar,[64] 21 per cent in that of Herbut and Clerf,[67] 36 per cent in that of Graham,[68] 40 per cent in that of Watson et al.,[66] and 26 per cent in that of Strieder.[69]

Other than the introduction of cytologic methods, little has been added to the diagnostic devices of the expert consultant in carcinoma of the lung. The value of bronchoscopy is well known, but Churchill's[62] statement should be emphasized:

> The purpose of bronchoscopy extends beyond the removal of a fragment of tissue to confirm the histologic diagnosis. . . . Unless the examination is carried out by an operator who is accustomed to make his observations in terms of the feasibility of a surgical attack on the lesion, the bronchoscopy may have to be repeated by one who is.

Bronchography is rarely indicated in diagnosis of cancer of the lung, and except under unusual circumstances may complicate further x-ray studies and clinical management of the case. It should be emphasized that x-ray study implies a real responsibility of the roentgenologist in assisting in the management of the patient, and not merely the routine chest film. Were it not for the great number of cases in which the observation is not made until late, it would seem superfluous to recall the importance of a careful palpation of the neck for metastases to lymph nodes. Simple biopsy of these may not only lead to the diagnosis but also determine the whole plan of management and save the patient prolonged hospitalization, often at considerable distance from home.

In summarizing the problem of early diagnosis and the management of the patient, Churchill[62] writes as follows:

> This review of the responsibilities of the expert consultant makes it obvious that he should have at his command a number of diagnostic technics that range from careful case history taking and physical examination, to thoracotomy for biopsy of a doubtful lesion. These responsibilities must be faced in logical sequence and carried through without delay. On the other hand, the consultant may indulge in certain assumptions relative to his responsibility that are not altogether warranted. Attention is called to these because they may retard the development of that close relationship between practitioner and specialist that is desired to promote progress in cancer control. They also directly influence the extent to which the patient will respond to the educational efforts that urge him to consult a physician in regard to early symptoms.
>
> One of these assumptions is that the expert must invariably exclude any possibility of cancer, however remote, by resorting to major diagnostic technics without regard to whether the clinical problem under consideration indicates their use. Another false assumption is that a presumptive clinical diagnosis always must be extended to histological confirmation despite the fact that the course of management is obviously not going to be altered by the reading of the microscopic slides. Finally, in deciding on the course that the management of an advanced case is to take, surgical exploration is oftentimes proposed as the

"only chance" and as such, one that cannot be denied the patient. In their quest for scientific exactitude the members of the profession must not confuse scientific precision with which certain parts of the evidence can be formulated, with the broad responsibility of weighing evidence as a whole. Courts of law may exact severe or even capital punishment if the evidence as a whole is judged valid "beyond any reasonable doubt." It is the responsibility of the consultant in conference with the family medical advisor to determine whether the "only chance" offered by surgical treatment is in truth a reasonable chance, or whether the cancer is surgically "out of bounds" beyond any reasonable doubt.

*(To be concluded)*

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## CASE RECORDS OF THE MASSACHUSETTS GENERAL HOSPITAL

### Weekly Clinicopathological Exercises

FOUNDED BY RICHARD C. CABOT

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### CASE 34501

#### PRESENTATION OF CASE

*First admission.* A thirteen-year-old girl entered the hospital complaining of pain in back of the left knee and in the hips.

The symptoms were first noted one and a half years prior to admission, following strenuous activity or occasionally after prolonged sitting in one position. The pain was usually relieved by resting the leg. X-ray films were taken at the time of onset of the pain and were reported as normal. However, repeat films six months later revealed undescribed changes. The patient was then placed in a spica cast for three months, followed by a nonweight-bearing cast for an additional six months. Neither the cast nor the brace effected much change in the symptoms, which continued as before. The pain was not too well localized but seemed to be mostly in the left groin and popliteal space. At first the pain was periodic and related to activity, but later became more or less continuous and was not affected by exercise or relieved by rest. Aspirin usually brought relief, which lasted about four hours. The patient ran a low-grade afternoon fever (temperature of 99.4 to 99.6°F.), but there were no chills, night sweats or cough.

The past and family histories were entirely irrelevant.

Physical examination showed a well developed and well nourished girl. Examination was entirely negative except for the left leg and hip. The legs were equal in length, but there was atrophy of the left thigh and calf. The hip was held in 20° permanent flexion. Rotation in extension was about two thirds normal. Abduction and adduction were very slightly limited. On flexion the hip went into 30° of permanent external rotation and into 20° of abduction at right-angle flexion.

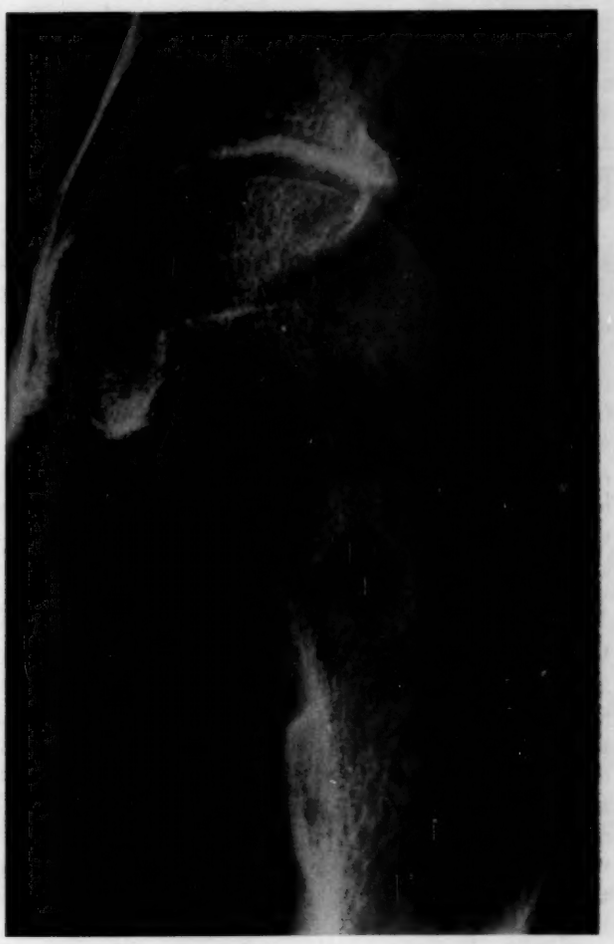

FIGURE 1.

The temperature was 99.8°F., the pulse 90, and the respirations 20. The blood pressure was 110 systolic, 65 diastolic.

Examination of the blood showed a hemoglobin of 14 gm. and a white-cell count of 10,900, with 59 per cent neutrophils, 30 per cent lymphocytes, 10 per cent monocytes and 1 per cent eosinophils. The

urine was normal. The blood calcium was 9.3 mg., the phosphorus 4.9 mg. and the alkaline phosphatase 3.9 units per 100 cc.

X-ray studies of the left hip showed a smoothly rounded area of slightly decreased density, measuring 1 cm. in diameter, in the neck of the femur. There was questionable slight bone reaction about the area of decreased density (Fig. 1). Examination of the pelvis, tibias, fibulas and skull was essentially negative. A tuberculin test was negative when given in 1:100,000 and 1:10,000 dilutions but positive at 1:1000.

The lesion was drilled through a lateral incision with a 0.79-cm. drill, and some material was curetted. Although it was believed that the drill had entered the lesion, microscopical examination showed only bone spicules. Subsequently the pain was less severe for several weeks but then recurred as before in the left hip and popliteal space. The patient had no other symptoms and was otherwise healthy.

*Second admission.* Five months after discharge she was again admitted for further study. Physical examination showed essentially the same findings as previously.

Examination of the blood showed a hemoglobin of 13.4 gm. and a white-cell count of 7200, with 64 per cent neutrophils, 23 per cent lymphocytes and 13 per cent monocytes. X-ray films revealed an oval defect 3 cm. in diameter in the neck of the left femur in the area previously described. On the second hospital day an operation was performed.

## Differential Diagnosis

Dr. Joseph S. Barr: I assume that the nonweight-bearing cast was actually a brace.

I might point out in passing that "although it was believed that the drill had entered the lesion, microscopical examination showed only bone spicules." Missing a small lesion that they are attempting to explore or to biopsy is an error that all orthopedic surgeons make. Almost all of us want to make certain and take x-ray films in two planes at the time of biopsy, with an instrument or metallic body at the area to assure correct localization.

Dr. Tracy B. Mallory: That was done in this case.

Dr. Barr: Apparently the lesion was missed in spite of that.

May we see the x-ray films?

Dr. James J. McCort: This examination was made preoperatively. A small, osteolytic lesion is present in the neck of the femur, measuring 1 cm. in diameter. The margins of this lesion show slight irregularity, but there is no sclerosis of the surrounding bone. The lateral view shows it to lie just beneath the anterior cortex of the femoral neck. There is no swelling of the soft tissue over it and no periostitis. Are you interested in seeing the postoperative films?

Dr. Barr: Yes.

Dr. McCort: This is the track made by the instrument at the time of the first biopsy. It appears to lead into the lesion. I cannot definitely identify it in the lateral view.

Dr. Barr: One can be directly over the lesion in one view and miss it by any distance in the opposite.

Dr. McCort: The long bones and skull are normal.

Dr. Barr: This thirteen-year-old girl had pain in the back of the left knee and in the hip. The onset of symptoms was at the age of eleven and a half years, and the pain was relieved by rest, although finally it became continuous but was somewhat relieved by aspirin. Other points are that the patient apparently ran a very slight fever throughout the course. The legs were equal in length, indicating that the lesion apparently was not near an actively growing epiphysis. If it had been at the epiphysis the length might have been decreased owing to interference with growth. Restriction of motion is interesting in that the leg on flexion went into external rotation and abduction. This finding is most common in slipped upper femoral epiphysis. However, in the slipped upper femoral epiphysis there is usually no permanent flexion but actual increase in hyperextension, and there was permanent flexion deformity in this case. Legg–Calvé–Perthes disease can cause restriction of motion similar to this. There is a rare condition called coxa magna in which the head of the femur is larger than normal and motion is restricted. If restriction of motion is due to muscle spasm, it does not assume this form. The leg may be adducted instead of abducted, and flexion is restricted without external rotation deformity. In addition to the slight elevation of temperature there may possibly have been slight elevation in the white-cell count. The lymphocyte-monocyte ratio was slightly elevated. The tuberculin test was positive; if it had been negative, it might exclude tuberculosis but since it was positive we cannot exclude tuberculosis.

In differential diagnosis I think we can exclude without much further consideration the generalized bone diseases, such as Hand–Schüller–Christian disease, polyostotic fibrous dysplasia and hyperparathyroidism; the skull showed no apparent lesions. The single lesions that we must consider are bone cyst, monostotic fibrous dysplasia, giant-cell tumor, enchondroma, Ewing's sarcoma and Hodgkin's disease, but I think none of them fit the picture very well. If this was a Ewing's sarcoma or Hodgkin's disease, with this duration, the patient should be either not alive or acutely ill, and we would have signs of progression of the process or involvement of the lungs or, in Hodgkin's disease, of the lymph nodes or elsewhere in the body. A bone cyst would not cause such acute symptoms as this patient had unless it had produced a frac-

ture, which was not present. Lesions that we should consider seriously are osteoid osteoma and eosinophilic granuloma. I do not believe that I can completely exclude them. Osteoid osteoma causes constant pain such as this, with insidious onset, often worse at night and almost always relieved by aspirin. So from the history that is a possibility. By x-ray examination, it cannot be completely excluded, but the films are certainly not characteristic of osteoid osteoma. There is usually much greater sclerosis of the bone as well as an area of decreased density. With good x-ray technic we can almost always demonstrate a small nidus in the center, which I do not see. Do you see it, Dr. McCort?

DR. MCCORT: No; I certainly do not see it.

DR. BARR: If a central nidus is not present, I think it is unlikely to be osteoid osteoma. I have not seen such a lesion without a nidus.

I have seen a few cases of eosinophilic granuloma but have never made that diagnosis preoperatively. I think this could have been an eosinophilic granuloma. The pain was consistent. There is usually a bone-destroying lesion, and that is about as much as I can say about it.

The mechanical things that we usually consider I think can be ruled out. We have a lesion within the neck of the femur, and I think we can rule out slipped epiphysis and Legg's disease and so forth. We then come definitely to infection, and the picture does fit an infectious process. The patient had continuous pain, possibly an elevation in temperature, rather continuously, and a little change in differential count and in the monocytic and lymphocytic ratio. Bone infections can go on for months or years with very little change in the appearance of the bone. If so, this obviously was a low-grade infection, and we have to consider the two main groups — a Brodie abscess or tuberculous infection of bone. I do not see how one can differentiate satisfactorily. A Brodie abscess usually produces more sclerosis than this, but I have seen *Staphylococcus aureus* infection of bone with practically no bone reaction about it, having been present a long time. Nevertheless, I lean a little toward tuberculosis. The tuberculin test was positive, and there was a very slowly progressive lesion in the central portion of the neck of the femur. I shall make a diagnosis of a low-grade infectious process, possibly tuberculosis.

DR. MARIAN ROPES: When I saw the patient before operation I had no idea what she had. I thought of the possibilities that Dr. Barr has mentioned; I did think she had definitely a synovitis and believed that the physical findings were consistent with that. I thought then and even at operation, when the synovial tissue in the hip was involved, that she had hemorrhagic villonodular synovitis with extension into the bone, although it was different from the average case that has been seen here at least. Beyond that I had no idea.

### CLINICAL DIAGNOSIS

Osteoid osteoma?
Tuberculosis?
Villonodular synovitis?

### DR. BARR'S DIAGNOSIS

Low-grade infectious process, possibly tuberculosis.

### ANATOMICAL DIAGNOSES

*Osteoid osteoma.*
Acute synovitis.

### PATHOLOGICAL DISCUSSION

DR. MALLORY: On the second occasion the hip joint was explored, and besides a diffuse synovitis, with considerable hypertrophy of the synovia, a localized lesion was found in the bone that appeared to penetrate the cortex in one or two spots. This was curetted out, and the material from the operation was divided into two lots, as we usually do with arthritic material, and the portion that we received showed nothing. We then asked the Arthritic Service to give us the other half, in which we found a characteristic osteoid osteoma. This is the first one we have seen in which the lesion had penetrated through the cortex of the bone; they are almost invariably subcortical. This one did not show much increase in density in the surrounding cortical bone, which is uncommon.

DR. BARR: What did the synovia show?

DR. MALLORY: Acute and chronic inflammation — there was nothing specific about its appearance at all.

DR. GRANTLEY W. TAYLOR: What were these cases called before they were identified as osteoid osteoma? The patients must have been seen and operated on from time to time.

DR. MALLORY: It seems most probable that they were reported as healing, sclerosing osteomyelitis.

DR. BARR: The evidence for neoplasm is still very uncertain in my mind in these lesions because one rather striking thing is that no matter how long they last they apparently never grow beyond 0.5 to 1.5 cm. in diameter. Did you do special stains for nerve fibrils?

DR. MALLORY: No.

DR. ROPES: We wondered what caused the synovitis. It must have been reaction to the material that penetrated from the cortex of the bone into the joint.

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## CASE 34502

### PRESENTATION OF CASE

*First admission.* A sixty-one-year-old woman, a schoolteacher, was admitted to the hospital because of nausea and vomiting.

Ten days previous to admission the patient suddenly developed nausea and vomiting unrelated to food and with no associated pain. In the preceding eight or nine weeks she had been taking two aspirin tablets every three hours because of pain in the left knee. There was no tinnitus or vertigo.

The past history revealed recurrent episodes of arthritis involving the right knee that began at the age of twelve and continued until the age of thirty, when pulmonary tuberculosis was diagnosed. On bed rest she recovered rapidly, and a fusion of the right knee was performed; tubercle bacilli were not isolated from the joint. She had no further pulmonary symptoms and no difficulty with the right knee except that due to its immobility. Ten years before admission, because of severe menorrhagia, a hysterectomy was performed, and a diagnosis of tuberculous salpingitis was made. Her maternal grandmother and two siblings had died of tuberculosis, but the patient was never exposed to the disease.

Physical examination revealed an obese, dehydrated woman with a slightly acidotic breath. The lungs were clear to percussion, with bronchovesicular breathing over the left apex and below the left clavicle. The right knee was fused in slight flexion. The left knee was slightly warm, and there was slight crepitation on motion.

The temperature, pulse and respirations were normal. The blood pressure was 126 systolic, 80 diastolic.

Examination of the blood revealed a hemoglobin of 12.4 gm. and a white-cell count of 10,300, with 62 per cent neutrophils. The urine specific gravity was 1.008, and the sediment contained occasional red cells and 4 pus cells per high-power field. The blood chloride was 82 milliequiv. per liter, and the nonprotein nitrogen 27 mg. per 100 cc. The fasting blood sugar was 87 mg. per 100 cc. The sedimentation rate was 40 mm. per hour.

An x-ray film of the chest showed fine, linear areas of increased density extending into the apex of the right upper lobe and one small calcified shadow. The film of the left knee showed considerable sharpening of the tibial spines but no joint narrowing or calcification. The right knee was fused. An upper gastrointestinal series was negative.

The patient was given sedatives and infusions were necessary initially, but she was later able to retain oral feedings. She was discharged improved after five days in the hospital.

*Second admission* (seven days later). Anorexia, nausea and occasional vomiting persisted after discharge. She became progressively weaker and was readmitted.

The physical findings were essentially as before.

The temperature was 98.2°F., the pulse 72, and the respirations 20. The blood pressure was 110 systolic, 70 diastolic.

Examination of the blood showed a hemoglobin of 14 gm. and a white-cell count of 8200, with 54 per cent neutrophils, 31 per cent lymphocytes, 13 per cent monocytes and 2 per cent eosinophils. A urine specific gravity of 1.012 was demonstrated; the sediment contained rare hyaline casts and rare pus cells. The stools were guaiac negative. The serum amylase was 35 units, the nonprotein nitrogen 35 mg., and the serum protein 5.3 gm. per 100 cc.; the chloride was 94 milliequiv. per liter. A barium enema, cholecystogram and intravenous pyelogram were negative.

Sedatives and later psychotherapy did not control the vomiting. After three weeks in the hospital the blood chemical findings were as follows: sodium 131 milliequiv., chloride 82 milliequiv. and potassium 6.1 milliequiv. per liter, sugar 97 mg. and total protein 5.1 gm. per 100 cc.

The patient lost 7 pounds in weight. Pigmentation of the buccal mucosa and of the creases in the palms as well as a generalized "tan" seemed evident to several observers. Six grams of salt daily, 5 mg. of desoxycorticosterone acetate daily, and later 2 cc. of lipoadrenal extract every six hours caused slight subjective improvement, but the blood chemical values were altered very little. Blood-pressure readings, which averaged 80 systolic, 65 diastolic, were elevated slightly. The vomiting continued but was less frequent, and intravenous fluids were still necessary. Testosterone, 10 mg. daily, was added to the therapy. Lipoadrenal extract was omitted. Desoxycorticosterone acetate, 10 mg. daily for several days, caused little alteration of the serum sodium content. After two months in the hospital the blood chemical values were as follows: sodium 124 milliequiv., chloride 102 milliequiv., and potassium 4.7 milliequiv. per liter, and serum protein 4.5 gm. per 100 cc. The twenty-four-hour urinary excretion of 17-ketosteroids was 0.7 mg. and of sodium chloride 2.3 gm. Omission of desoxycorticosterone acetate caused anorexia, vomiting, diarrhea and loss of weight but little change in blood pressure. An adrenocorticotropic hormone test showed no significant change in the blood eosinophil count or urinary creatinine and uric acid. She was discharged with implanted pellets of desoxycorticosterone acetate after four months in the hospital.

*Final admission* (ten weeks later). While at home the patient was ambulatory but vomited almost daily. She had a spell of confusion three weeks and two weeks before admission. These were of one and four hours' duration, respectively. Eight hours before admission this recurred, and she became unresponsive and later comatose.

Physical examination revealed a comatose woman. There were bilateral basal moist rales. Neurologic examination was negative.

The temperature was 99°F., and the respirations 20. The blood pressure was 170 systolic, 110 diastolic.

Laboratory data included a hemoglobin of 14.8 gm. The urine gave a ++ test for albumin, and the sediment contained occasional granular casts, 10 white cells and a rare red cell per high-power field. A blood sugar determination was 41 mg. per 100 cc.

Intravenous glucose was followed by rapid recovery of consciousness. The following day the temperature was elevated to 102°F. She vomited frequently and, despite intravenous therapy, died on the second hospital day.

## Differential Diagnosis

Dr. Joseph C. Aub: This seems to be such an obvious case that I am certain that the pathologists have it in for me. Obviously, it is a case in which they want a diagnosis of Addison's disease, and I cannot make any other diagnosis.

One can ascribe the trouble in the knee to tuberculosis. If the pathologists diagnosed tuberculous salpingitis, we have to assume that this woman had tuberculosis.

The blood chloride level is recorded as 82 milliequiv., and yet she had a normal blood pressure at that time. I do not understand that.

The intravenous pyelogram in the second admission was negative; that is important, considering the high blood pressure at death.

It should not be forgotten that cases of Addison's disease are often diagnosed as psychoneurosis. If these people do have Addison's disease, psychotherapy does not help much.

The weight loss is important because all patients with Addison's disease lose weight. They do not look thin, but all have a history of loss of weight. This patient had vomiting, of course, which complicates this fact but goes with Addison's disease.

A biopsy of the buccal mucosa would have been helpful, but I am assuming that the patient had a generalized pigmentation.

The excretion rate of 17-ketosteroids is negligible, and this is important as evidence for Addison's disease. The urine sodium of 2.3 gm. does not mean anything. Every well person eats from 2 to 15 gm. of sodium chloride a day, and much of this comes out in the urine. Excretion of 2.3 gm. in twenty-four hours is not high for a normal person, but it varies with the diet and medication.

It is not unusual in Addison's disease to find an associated low blood sugar, such as this patient had on her final admission, and this is considered an ominous prognostic sign.

The temperature was high for a woman in an Addisonian crisis.

A weak heart goes with Addison's disease, and she may have had too much intravenous salt, dying of cardiac complications.

There are a great many things that I would like to know about this case. I am not going to ask for anything, however. (Your host gives you a certain number of data, and you accept them; I do not ask for more.)

May we see the x-ray films?

Dr. Stanley M. Wyman: The film of the chest is not of ideal quality. It shows calcification in the right-upper-lung field and, I think, a questionable area of fibrosis in the right apex. The heart shadow is not small; in fact, it appears somewhat prominent toward the left, possibly in the left ventricle. The aorta is quite tortuous.

Dr. Oliver Cope: When was this film taken in relation to death?

Dr. Walter Bauer: About six months before death.

Dr. Wyman: The right knee shows an old fusion as described in the physical examination.

Dr. Aub: Can you ascribe a cause to that appearance?

Dr. Wyman: I cannot say. It is just a fused knee.

The gastrointestinal examination shows a small hiatus hernia; the stomach and colon are normal without evidence of defects. I do not see calcification in the region of the adrenal glands.

Dr. Aub: Is there anything in the spine?

Dr. Wyman: There is no evidence of active disease.

The kidneys are normal in size and shape. A film twenty minutes after injection of dye shows fairly good excretion. There is no calcification above the kidneys. The skull examination, not mentioned in the protocol, shows rather prominent vascular lakes in the base; I can see no definite evidence of localized disease or chronic increased pressure. The pituitary body is of good size and not abnormal.

Dr. Aub: I do not believe there is good evidence for tuberculosis in the lung, is there?

Dr. Wyman: There is no definite active disease.

Dr. Aub: I cannot make any diagnosis except Addison's disease. I should like to know what happened to the size of the heart as the disease went on and as the patient got worse. I should like to know what the basal metabolic rate was, and what the diuresis following ingestion of water was. She had orthopnea, nausea and vomiting, hypoglycemia, probable loss of weight, syncopal attacks, pigmentation, a diagnosis of neurasthenia, low blood chloride and a low blood sugar — all these are consistent with Addison's disease. I believe she died in an acute Addisonian crisis, with hypoglycemia. She had been given a good deal of fluid, and she responded very poorly.

The blood pressure was 170 systolic, 110 diastolic, when she came in in an Addisonian crisis. This is most unusual and puzzling. It is possible that the patient's physician gave large doses of desoxycorticosterone acetate and much intravenous therapy.

When one is presented with a problem like this, one can always bring in a great many diagnoses just for the sake of naming the diagnosis, but I do not like to do that. I think this woman died of Addison's disease with tuberculosis of both adrenal glands. There is evidence for tuberculosis in what I take to have been a tuberculous knee joint, tuberculous salpingitis and also scrofula in the bone. I would expect that she had tuberculous lymph nodes scattered through the abdomen and that she had a tuberculous peritonitis.

What about the kidney? The urine had a low specific gravity and red cells and a good deal of albumin at the end. She may have had amyloidosis or, what is much more likely, tuberculous involvement of the kidneys, which did not show up in the poor pyelogram that was done. She obviously had something seriously wrong with the kidneys. Let us make two diagnoses: tuberculosis and amyloidosis of the kidneys. Of course, she may have had a malignant tumor involving both adrenal glands, which had destroyed them, with widespread metastases. I do not think we have enough evidence to make such a diagnosis. Recalling the high blood pressure, I think it possible that she was overtreated with intravenous salt on the last entrance to the hospital and that, as a result, she had edema of the lungs with cardiac decompensation. This may be wrong, because with high blood pressure and low blood sugar, the tendency would have been to give glucose and water and not glucose and salt; yet I suggest that she had edema of the lungs. I think she had Addison's disease, which did not respond to desoxycorticosterone acetate because the carbohydrate metabolism was abnormal. It is obvious that with such an abnormality the prognosis is grave, and the response to adrenocortical extract is not always good, particularly if there is an active tuberculosis or other infection.

Dr. Tracy B. Mallory: Dr. Bauer, did you see this patient?

Dr. Bauer: Yes, indeed, I did. I saw her during the second hospital admission because of her joint disease. One of the members of our group had seen her some months before and thought she had mild rheumatoid arthritis. I must say that when I saw her there was very little in the way of objective findings in the left knee that one could be certain of. The diagnosis rested between tuberculosis and rheumatoid arthritis; however, there was no way of proving either diagnosis. I saw this woman quite a few times and must admit that I felt very strongly that her symptoms were largely psychogenic in nature despite some pigmentation and findings that were in keeping with Addison's disease. Dr. Lindeman saw her and agreed to the possibility of a psychogenic illness; however, he did not think it was the sole cause of her chief complaints. What psychotherapy she received from him was the result of my insistence. I think she received very adequate therapy for the adrenal insufficiency.

Dr. Daniel S. Ellis: It is hard now to believe that there was as much difficulty in arriving at a decision in this case as there actually was. But as Dr. Bauer has intimated, the diagnoses considered ran from psychoneurosis to cancer. One observer felt very strongly that she should be operated on. What puzzled us on the long second admission was that she did not respond to adequate therapy for adrenal insufficiency. There were doctors of the house staff and some others who felt strongly that it was, without question, a serious consideration and an important one.

Dr. Aub asked for certain things that I might supply as far as I can. The basal metabolic rate was + 1 and — 8 per cent, and the water-excretion test was not done because of the opinion that it was not so accurate as the eosinophilic and uric acid test with adrenocorticotropic hormones. The results of these, as given in the protocol, were definitely consistent with Addison's disease. There was no change in the uric acid excretion, and the eosinophilic count remained the same, which is true in Addison's disease. Normally, the eosinophilic count falls, and there is increase in uric acid excretion. During the time between the second and third admissions she was at home. For the first month at home the blood pressure was around 105 systolic, 60 diastolic. Because she began to vomit more and eat less and continued to lose weight, in addition to fluids, we decided to give her 5 mg. of adrenocortical hormone a day intramuscularly. This was done for another four weeks without any apparent effect. Then she had the onset of these episodes of loss of consciousness, and it was found that at each of the three episodes the blood pressure was higher than it had been on admission: 130 systolic, 70 diastolic, at the first episode; 155 systolic, 90 diastolic, at the second; and 170 systolic, 100 diastolic, at the last. As far as the last admission is concerned, it was believed that she was in a hypoglycemic crisis when she came in. No additional adrenal hormones were given at first; she was given intravenous glucose, and twelve hours later the blood pressure fell to 70 systolic, 40 diastolic. At that time she was given lipoadrenal extract for obvious reasons, which I cannot go into now. It was felt that diuretic therapy should not be given this patient and as far as specific therapy for Addison's crisis was concerned, over a course of thirty-six hours she received 3 cc. of lipoadrenal extract and 5 cc. of desoxycorticosterone acetate and that is all.

Dr. Aub: I am fascinated by the elevation of blood pressure with the hypoglycemic reaction. With hypoglycemia one gets increased flow of epinephrine. That might raise the blood pressure, but in Addison's disease, one would not expect it, for the adrenal medulla should not be available if

involved with tuberculosis. There remains the possibility of making adrenalin in the sympathetic nerve ganglions. It is possible that she had enough ability to secrete epinephrine from the ganglions scattered throughout the body to give a high blood pressure. But I think it very unlikely.

### Clinical Diagnosis

Addison's disease.

### Dr. Aub's Diagnoses

Addison's disease.
Tuberculosis of adrenal glands.
Tuberculosis and amyloidosis of kidneys.

### Anatomical Diagnoses

*Addison's disease.*
*Bilateral cortical infarction of kidneys.*
*Tuberculosis of adrenal glands, lungs and lymph nodes.*
Pulmonary edema.

### Pathological Discussion

Dr. Mallory: This patient had the anatomic substrate for Addison's disease — complete tuberculous destruction of both adrenal glands. There was tuberculosis elsewhere — it was very extensive in the lungs, though of a low degree of activity. There were also numerous tuberculous lymph nodes scattered throughout the body. The right knee was explored and showed an anatomic fusion of the joint but no evidence of tuberculosis. We unfortunately did not know about the symptoms in the other knee, which was not looked at.

The kidneys were a considerable surprise. They weighed 260 gm. The cortex was 4 or 5 mm. in thickness and very slightly scarred; but on microscopical examination it is evident that there was almost complete infarction of the renal cortex. Only a very narrow rim of cortex at the periphery just beneath the capsule and the pyramids was still visible. This symmetrical cortical infarction, of course, is well known as a complication of pregnancy but does occur in other conditions, and occurs occasionally in members of the male sex. I have never heard of it before in relation to Addison's disease. Whether it can be linked directly to the Addison's disease or should be considered a peculiar complication of the therapeutic measures utilized I cannot answer. It can readily be explained by the mechanism that Trueta* has recently described of reflex shunting of the renal blood flow into the vasa vitae of the pyramids, with consequent cortical ischemia.

Dr. Aub: Was there any amyloidosis?

Dr. Mallory: No; there was a moderate amount of still recognizable focal lymphocytic infiltration in the kidneys. I think a moderate grade of pyelonephritis existed before this final episode, which was very acute — of only two or three days' duration, I would guess.

Dr. Benjamin Castleman: Do you think that the kidney lesion was the cause of death?

Dr. Mallory: I think that the renal lesion undoubtedly had a great deal to do with death and probably was the immediate cause. There was a moderate grade of pulmonary edema.

Dr. Cope: Was the renal lesion the probable cause of hypertension?

Dr. Mallory: Hypertension is characteristic of the syndrome of symmetrical cortical necrosis.

Dr. Aub: This case demonstrates an important potential in the Addisonian patient. In the past I have seen a patient menstruate normally in the midst of an Addisonian crisis in spite of a lack of the adrenal hormones. Here we see an example of a Goldblatt hypertension during a crisis, which demonstrates that the mechanism of this hypertension is distinct from the adrenal gland.

*Trueta, J., et al. *Studies of the Renal Circulation.* 187 pp. Springfield Ill.: Charles C Thomas, 1947.

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## *PRO RE NATA*

THE world is always in revolution. Sometimes its shifts and changes, and re-alignments are so quiet that they signify only the placid progress of a world at peace; at times, like the present, they consist of such general turbulence that every race, every social and economic group, every industrial and professional alliance seems to be pressing for room in which to function, for prestige, sometimes for existence itself.

Less than a hundred years ago nursing rose from a menial service, often degrading in character, and attained the distinction of a profession. Today this profession finds that it must again adapt itself to violently changing conditions of supply and demand and of social unrest and must find the position that will secure for it the broadest possible field of future usefulness.

In this contingency the National Nursing Council turned to the Russell Sage Foundation for assistance. A study has been made by Esther Lucile Brown, Ph.D., director for the Foundation of the Department of Studies in the Professions, and her report, *Nursing for the Future*, a review of which is published elsewhere in this issue of the *Journal*, is the tangible result.

Maintenance of health rather than the treatment of disease is the future goal of medicine as horizons expand in medical care, in hospitals and in private practice, in public health and in preventive medicine. Nursing must keep pace with these expansions of health services. Hospitals and all the other agencies of health will need an enormous supply of nursing care, and, as "private duty has become proportionately less important," according to Dr. Brown's thesis, "salaried institutional, public health and industrial nursing has come to be largely considered a social necessity."

Nursing service must be still further differentiated according to function. Not only must the place of the registered graduate nurse be considered, but also the necessity for other grades of nurses. Someone must carry on the simpler functions of nursing at a cost to the consumer that will not put decent care in sickness beyond the reach of the ordinary patient.

The status of the practical nurse must be fixed by legislation, but the attractiveness of her position will depend on the interpersonal relations that will exist in the schools of her training and the situations in which she will work. So far there has been an inevitable tendency on the part of the graduate nurse to disparage the use and the quality of less highly trained personnel that introduces the element of lower-priced competition. This attitude must change if the officers of the nursing corps of the future are to find any devotion and loyalty in the ranks.

The position of the practical or the attendant or the bedside nurse must be made secure, and her training must be carried on partly inside the hospital, where her school may coexist with that of the professional nurse. This may also be linked, as

suggested by the Professional Advisory Committee of the study, with the public-school system; in any event, the profession of nursing, the medical profession and the public must be interested and sympathetic in creating a desirable position for the attendant nurse.

Certain other observations and recommendations have been made in Dr. Brown's report. Of the group of 1125 schools of nursing that participated in the program of the Cadet Nurse Corps, only 13 per cent received a rating by the United States Public Health Service of good or better. This group is made up of the schools that are producing the graduate nurses of today. The current graduate bedside nurse may, indeed, disappear from the scene when nursing of the future is organized on the two levels proposed.

One of these levels will consist of the professional nurses, whose training will be limited to the schools that can provide instruction of a grade recognized by educators as professional. These schools will belong in institutions of higher learning and will furnish both cultural education and first-class technical training. They will be on a par with the other university schools, and their graduates, as bachelors of science, will serve in technical fields in community health services, in supervisory activities, in executive positions, and in research and teaching.

The nonprofessional nurses, with their more limited training, will supply the bedside nursing in the hospitals of the future and, presumably, of the nation's homes. The great need for adequate household service seems to have been largely lost sight of in the preoccupation of the report with the demands of instititions and their hospitalized patients. There are, however, those who still remember that many of the vigils that the nurse must hold in discharging her highest functions are by the sickbeds in the home. Perhaps this need will be met to an increasing degree inside the family itself, by those who have profited from the Red Cross Home Nursing courses. God helps those, it is still widely believed, who help themselves.

Nursing, like all the other activities in which humankind engages, is passing through one of its crises. There is, it is said, a shortage of nurses, but as with the shortage of physicians it is the result of an increased demand for a type of service rather than of any relative decrease in the personnel capable of providing it.

The Commonwealth of Massachusetts is meeting the problem perhaps as intelligently as any state. There is here already the licensed attendant nurse who is filling a need and has achieved a dignity of her own. She is, moreover, gaining in prestige and in recognition by her more highly trained nursing colleagues.

The profession of nursing needs more help and less criticism; more in the way of respect and less in the way of condescension from others. Perhaps it is not too much to expect that it may some day have its own board of registration with a nurse as secretary and that the Massachusetts Medical Society, as an indication of its own desire to cooperate, may create a special committee to meet with the Massachusetts State Nursing Association.

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## INFLUENZA AND PNEUMONIA

EACH year after the leaves have fallen, the winds and the chill in the air herald in a new "respiratory season." People begin to get colds, many of them have coughs that seem to hang on, and doctors encounter cases of pneumonia and wonder whether there will be any severe outbreak of influenza. Thirty years ago, late in the summer of 1918, a worldwide epidemic struck the Atlantic seaboard and soon swept across the country, attacking about 20,000,000 people in the United States, of whom an estimated 550,000 died of the disease or its complications. Previously, such major outbreaks had recurred at intervals of about twenty or thirty years. Though there has been no cyclic regularity to the occurrence of such pandemics, there is an understandable apprehension that one may strike again. The dread of pandemic influenza is heightened, of course, by the lack of precise knowledge concerning the true cause of the previous great pandemics, and for that reason only slight solace can be taken from the vast amount of recently accumulated knowledge concerning the comparatively mild epidemics due to the influenza A and B

viruses that have been recurring every two or three years.

Some comfort may, nevertheless, be derived from a recent review by the statisticians of the Metropolitan Life Insurance Company* of the figures on mortality from influenza and pneumonia during the past few years. A most significant downward trend in the figures began in the early 1930's, when specific serum treatment for many types of pneumonia was introduced. Among the Company's industrial policyholders the death rate dropped from 80 per 100,000 in 1930–31 to about 70 per 100,000 in 1936–37, the period during which this type of therapy came increasingly into use. In 1938, when both serum and the sulfonamides were used, the death rate from pneumonia and influenza dropped sharply to 47 per 100,000 — a decrease of almost 35 per cent from the year before. Improvements in sulfonamide treatment and the introduction of penicillin brought still further success, so that by 1947 the death rate reached an all-time low of 17.4 per 100,000, and it is expected that this will fall still further during the current year. The efficacy of newer methods of treatment is clearly evident from the fact that improvement in mortality has been relatively three times as great in the past decade as in the previous one. Between 1935–37 and 1947 the decrease was more than 60 per cent in every age group among white persons of both sexes, and in most age groups the reduction in the death rate was greater than 75 per cent.

Some forms of pneumonia are still not amenable to treatment. Some of the virus pneumonias are in this category, and there is always a possibility that some virulent form of these pneumonias will occur. Moreover, there is no assurance that a devastating epidemic of influenza similar to that of 1918 will not strike again. So far this year, however, there are no signs pointing to the likelihood of a severe influenza epidemic in the United States or elsewhere. This is unlike the situation in 1918, when months before there were serious outbreaks in various military installations in this country and also in various parts of Europe. Even if such an epidemic should occur, the medical and public-health professions are much better prepared to cope with the situation now than they were thirty years ago. It is well recognized that the uncomplicated cases of influenza cause relatively few deaths even during pandemics. Most of the deaths occur among cases complicated with severe forms of pneumonia. With the help of the sulfonamides, penicillin and other antibiotics that are now available, physicians should be able to control the complications and thus rob the next pandemic of most of its terrors.

*Influenza and pneumonia — thirty years after the pandemic. *Statist. Bull., Metrop. Life Insur. Co.* **29** (No. 9): 8-10, 1948.

## EMINENT CARDIOLOGIST

Dr. Paul Dudley White, of Boston, has been appointed chief adviser for the National Heart Institute and executive director of the National Advisory Heart Council, established by Congress last June as an activity of the United States Public Health Service. Dr. White, who has been physician in charge of the Cardiac Clinic and Laboratory of the Massachusetts General Hospital, has resigned from that position to assume his new duties, which will require a division of time between Boston and the headquarters of the National Heart Institute at the National Institutes of Health, Bethesda, Maryland.

A graduate of Harvard College in the class of 1907 and of the Harvard Medical School in 1911, Dr. White in April, 1948, received the Order of the White Lion from the Czechoslovakian Government, on the occasion of the six hundredth anniversary of the founding of Charles University, in Prague. This award was made as the result of his participation in the medical mission of the Unitarian Service Committee to Czechoslovakia in 1946.

## MASSACHUSETTS MEDICAL SOCIETY

### HAMPDEN DISTRICT

The Hampden District Medical Society is to be congratulated on the excellent manner in which it has responded to the request of the Council, made in May, that the districts form their own plans for full-time coverage of calls for physicians.

Lists have been issued classifying the members of the district society according to types of practice, and from these a house-call classification sheet has been constructed containing the names of those physicians in the various communities of the district who are willing to respond to emergency calls, and the times at which they are available.

DEATHS

DAHLEN — Carl A. Dahlen, M.D., of Brookline, died on October 23. He was in his fifty-seventh year.

Dr. Dahlen received his degree from Tufts College Medical School in 1918. He was a member of the dermatologic staff at Massachusetts Memorial Hospitals and was a fellow of the American Medical Association.

His widow, a son, a daughter and two sisters survive.

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HOLT — Earl K. Holt, M.D., of Medfield, died on November 10. He was in his sixtieth year.

Dr. Holt received his degree from Indiana University School of Medicine in 1914. He was superintendent of the Medfield State Hospital and a member of the American Psychiatric Association and the New England Society of Psychiatry.

His widow and a son survive.

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RAYMOND — Loring H. Raymond, M.D., of Somerville, died on November 6. He was in his seventieth year.

Dr. Raymond received his degree from Harvard Medical School in 1903. He was a fellow of the American College of Surgeons and the American Medical Association.

His widow survives.

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## MASSACHUSETTS DEPARTMENT OF PUBLIC HEALTH

### COMMUNICABLE DISEASES IN MASSACHUSETTS FOR OCTOBER, 1948

RÉSUMÉ

| DISEASE | OCTOBER 1948 | OCTOBER 1947 | SEVEN-YEAR MEDIAN |
|---|---|---|---|
| Chancroid | 2 | 4 | 2* |
| Chicken pox | 622 | 309 | 370 |
| Diphtheria | 29 | 21 | 17 |
| Dog bite | 751 | 888 | 842 |
| Dysentery, bacillary | 5 | 60 | 39 |
| German measles | 47 | 52 | 52 |
| Gonorrhea | 284 | 334 | 413 |
| Granuloma inguinale | 1 | 1 | 0* |
| Lymphogranuloma venereum | 1 | 0 | 1* |
| Malaria | 1 | 4 | 16 |
| Measles | 660 | 120 | 401 |
| Meningitis, meningococcal | 7 | 6 | 11 |
| Meningitis, Pfeiffer bacillus | 2 | 2 | 3 |
| Meningitis, pneumococcal | 1 | 2 | 2† |
| Meningitis, staphylococcal | 0 | 0 | 0† |
| Meningitis, streptococcal | 0 | 0 | 0† |
| Meningitis, other forms | 0 | 0 | 0† |
| Meningitis, undetermined | 8 | 2 | 2† |
| Mumps | 485 | 374 | 335 |
| Pneumonia, lobar | 60 | 68 | 159 |
| Poliomyelitis | 31 | 65 | 65 |
| Salmonellosis | 8 | 14 | 13 |
| Scarlet fever | 243 | 273 | 456 |
| Syphilis | 141 | 322 | 408 |
| Tuberculosis, pulmonary | 181 | 228 | 236 |
| Tuberculosis, other forms | 11 | 19 | 19 |
| Typhoid fever | 2 | 6 | 4 |
| Undulant fever | 2 | 3 | 5 |
| Whooping cough | 180 | 460 | 554 |

*Four-year median.

†Six-year median.

COMMENT

The diseases with an incidence above the seven-year median were chicken pox, diphtheria, measles and mumps.

The diseases with a prevalence below the seven-year median were bacillary dysentery, meningococcal meningitis, lobar pneumonia, poliomyelitis, pulmonary tuberculosis and whooping cough.

Chicken pox was at the highest level ever reported for October, which may indicate that it will continue at the high level of recent months.

Diphtheria was at the second highest level since 1935. The communities primarily affected continued to be Boston and those immediately to the north.

Measles was at the highest level for October since 1928. It seems likely that the high prevalence of recent months is to continue.

Mumps was at the highest level ever reported for October. A continued high prevalence can be expected during the coming season.

Only three times in the past has scarlet fever been lower in October than prevalence recorded for the month. The high prevalence of recent months, after repeated record low levels last year, makes it likely that the disease will be on the increase during the coming season.

Whooping cough was at the lowest prevalence recorded since 1916. It is unlikely, however, that this low figure can be maintained, and the coming season will probably show a considerable increase.

GEOGRAPHICAL DISTRIBUTION OF CERTAIN DISEASES

Diphtheria was reported from: Arlington, 2; Berkley, 1; Boston, 14; Cambridge, 1; Chelsea, 1; Danvers, 1; Easton, 1; Everett, 1; Hanover, 1; Malden, 3; New Bedford, 1; Somerville, 1; Watertown, 1; total, 29.

Dysentery, amebic, was reported from: Stoneham, 1; total, 1.

Dysentery, bacillary, was reported from: Stoneham, 1; Newburyport, 1; Worcester, 3; total, 5.

Encephalitis, infectious, was reported from: Clinton, 1; total, 1.

Lymphocytic choriomeningitis was reported from: Cambridge, 1; Worcester, 1; total, 2.

Malaria was reported from: Barnstable, 1; total, 1.

Meningitis, meningococcal, was reported from: Boston, 2; Haverhill, 1; Lynn, 1; Randolph, 1; Worcester, 2; total, 7.

Meningitis, Pfeiffer bacillus, was reported from: Hatfield, 1; Lawrence, 1; total, 2.

Meningitis, pneumococcal, was reported from: Barnstable, 1; total, 1.

Meningitis, undetermined, was reported from: Andover, 1; Beverly, 1; Brockton, 1; Dudley, 1; Northampton, 1; Spencer, 1; Weymouth, 1; Worcester, 1; total, 8.

Poliomyelitis was reported from: Amherst, 1; Attleboro, 1; Belmont, 1; Boston, 2; Brookline, 1; Cambridge, 1; Danvers, 3; Littleton, 2; Lynnfield, 1; Marblehead, 1; Medford, 1; Middleboro, 1; Palmer, 1; Plymouth, 1; Salem, 2; Shrewsbury, 1; Springfield, 2; Warren, 1; Wellesley, 1; West Springfield, 1; Worcester, 5; total, 31.

Salmonellosis was reported from: Beverly, 2; Stoneham, 1; Wakefield, 1; Worcester, 4; total, 8.

Septic sore throat was reported from: Boston, 9; Lynn, 1; Stoneham, 1; West Newbury, 1; total, 12.

Tetanus was reported from: Cambridge, 1; Pittsfield, 1; total, 2.

Trachoma was reported from: Lynn, 1; total, 1.

Trichinosis was reported from: Boston, 1; Fall River, 1; total, 2.

Typhoid fever was reported from: Brockton, 1; Springfield, 1; total, 2.

Undulant fever was reported from: Holyoke, 1; Norwood, 1; total, 2.

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## BOOK REVIEWS

*Nursing for the Future.* By Esther Lucile Brown, Ph.D. 198 pp. New York: Russell Sage Foundation, 1948. $2.00.

The avowed objective of Dr. Brown's "Nursing for the Future" is refreshing. She states, "First, and most important, was the decision to view nursing service and nursing education in terms of what is best for society — not what is best for the profession of nursing as a possibly 'vested interest.'" Quite rightly she says of the nurses that "Many have kept their attention so focused upon professional rights and prerogatives that society has sometimes come to question their interest in serving the needs of our national life."

How closely the author adheres to her objective might be questioned, but her report, based on painstaking investigation, contains many facts and observations that should be helpful. "So long as attention is centered on the graduate nurse, no other avenue is open except that of the present frantic and probably futile effort to recruit more prospective R.N's. Even appreciably better educational preparation is likely to be denied them, so insistent will the demand for nursing service continue to be. Once emphasis is shifted to nursing, however, several roads seem to point to potentially larger supplies of service and to possibly increased efficiency both on the nonprofessional and the professional levels." It is cheering to learn this.

Observing that everyone desires the best in nursing service but that competent graduate nurses must be used for supervision, administration and teaching, Dr. Brown wisely concludes, "We are still far from discovering a financial method whereby the finest in nursing could be furnished to everyone in need. At least it is assumed that neither the patient nor the institution should pay for graduate nursing, if any part of that nursing could be done as efficiently by persons with shorter preparation." Only too true is her statement that the profession has difficulty in visualizing concomitant assistant and professional nursing services, but without them, she says, ". . . we shall almost inevitably have to continue to depend on the graduate bedside nurse as we do today, regardless of the fact that her training has been too long and expensive for performing the simpler functions. . . ."

Dr. Brown then proceeds to outline three grades of nursing service: professional, nonprofessional and an intermediate group. "In the case of the graduate general nurse, however, emphasis needs to be placed only on preparation for bedside care and some understanding of what constitutes a complete health service." She calls attention to the fact that the Committee of Interests in Accreditation ". . . visualized three classes of members: schools offering the basic curriculum, schools offering advanced curricula, and schools preparing practical nurses." If we add to this the proviso that those demonstrating the ability may progress from grade to grade, we have in effect the recommendation recently adopted by the American Medical Association. When such groups of nurses and physicians are in agreement that three grades of nurses should be trained, and the former comes to the realization that with this plan " . . . nurses will be given a better opportunity to devote themselves to those aspects of clinical practice that require true professional skill . . .," progress should be swift.

Many hospitals, says Dr. Brown, are discussing the opening of such schools for practical nurses in addition to their "regular" schools, but "At present provisions for the preparation of practical nurses are negligible when compared with what are needed." "What is advocated . . . is conviction, not lip-service alone, on the part of the nursing profession . . . hospital administrators, and the laity concerned with social change, that new patterns of nursing service must be evolved both in behalf of adequacy of supply and of quality." And further, "*No system of training for practical nurses is likely to succeed unless the public . . . educators . . . hospitals . . . nursing associations and state boards of control . . . are prepared to manifest an active interest in practical nursing far beyond any interest yet shown.*" "Not only the availability of nursing care for large portions of the population, but also the future status of professional nursing itself will be determined by the degree to which rapid and effective action can be achieved in this long neglected field."

In the last two thirds of the book, Dr. Brown seems to forget the original objective of what is best for society and to fall under the influence of her advisory committees, composed almost entirely of the leaders of advanced nursing education and from the academic sphere. Since the poor patient is inarticulate, the counsel of a committee of hospital administrators charged with his bedside care, and of doctors responsible for the therapy administered by the nurse might have been helpful. In spite of the fact that there is a dearth of top-grade nurses for administration, teaching, and the aspects of clinical practice requiring true professional skill, Dr. Brown points out that even where university affiliation exists, "Relatively few of these students have exhibited an interest in obtaining a degree. . . ." Under these circumstances, the emphasis on the need for greatly expanding the opportunities for truly higher education may be questioned, and those primarily interested in the care of the patient may resent the repeated reference to the hospital as the "laboratory" for such institutions of learning. It perhaps recalls too sharply the point of view of the student who wrote, "The patient is the medium through which the nurse expresses her personality."

Aside from this overemphasis on higher education, Dr. Brown's book contains much valuable information and common sense. It will be a pity if hospital administration does not integrate the points presented into a plan of action to extricate itself from the present dilemma of nursing service.

*The Pathology of Nutritional Disease.* By Richard H. Follis, Jr., M.D. 8°, cloth, 291 pp., with 71 illustrations. Springfield, Illinois: Charles C Thomas, 1947. $6.75.

To those who have not had the opportunity of following the literature on nutrition as it has developed, the problem of orientation in such a complicated, widely applied and somewhat confused field is likely to require so much time as to be prohibitive. Consequently, the appearance of a book that aims at a stocktaking and a clarification of confused issues is warmly welcomed by students and clinicians, if not by those in the research field.

Dr. Follis has undertaken the rather ambitious task of discussing the pathophysiology and histopathology resulting from a deficiency of forty-two nutrients essential to mammalian metabolism. He has wisely eliminated many of the early investigations in which the findings were complicated by a multiplicity of deficiencies; he has attempted to restrict himself to those in which, so far as present knowledge is concerned, a single deficiency acts as a limiting factor. The result is a clear demonstration of the wide gaps in knowledge of the specific roles of many of the so-called dietary essentials. Regarding human metabolism these gaps are exceedingly large, and somewhat startling, when compared with the abandon with which the nutrients are used in clinical medicine.

Not only does the author discuss the specific effects of single deficiencies, but also, whenever possible, he indicates the interrelation of various factors. Thus, the interrelations of choline, methionine and cystine, of tryptophane and niacin, of ascorbic acid and phenylalanine and tyrosine and so forth are briefly but concisely considered.

Since the factors discussed are likely to be essential for a variety of tissue cells, it is not surprising that a deficiency of any one may be manifested by morphologic and physiologic lesions in a number of different tissues. Conversely, distortions of structure and function may develop in a given tissue as a result of a deficiency of several factors occurring independently. The author has attempted to emphasize this by approaching his subject initially from the point of view of the individual factors and finally from the point of view of specific tissues.

In this era of unbridled enthusiasm over various concoctions of essential nutrients, it is a healthy sign that a book such as this has been written. If it succeeds in but one thing — a serious re-evaluation of the use of vitamins in clinical medicine — it will have served a useful purpose.

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*Brief Psychotherapy: A handbook for physicians on the clinical aspects of neuroses.* By Bertrand S. Frohman, M.D. With the collaboration of Evelyn P. Frohman, and with a foreword by Walter C. Alvarez, M.D. 12°, cloth, 265 pp. Philadelphia: Lea and Febiger, 1948. $4.00.

This handbook, written particularly for the general practitioner, has many features that will make it attractive to the beginner in psychiatry. Its simple, direct presentation and good glossary make it useful also for the educated patient.

Although it stresses practical clinical approach, theory has been cleverly introduced into the discussions, and advanced in an appealing manner. Case reports, brief and to the point, are interspersed throughout the text. Failures and difficulties are admitted — a rare finding in psychotherapeutic literature.

The psychoneuroses are carefully differentiated, and pitfalls in diagnosis are shown. Etiologic factors are reviewed in an excellent section, being separated according to age groups. There are special chapters on neuroses encountered in the specialties.

The main methods of treatment are given with their indications, and brief psychotherapy is described in more detail. There is a good bibliography.

The orthodox psychoanalysts will disagree with much that is presented in the section on therapy, and there are a few other points in the text that one might criticize. Despite these minor considerations, the book is a most welcome addition to the small group, now available, that present psychotherapy in a concise and practical form for the general practitioner.

*Diabetus Mellitus in General Practice.* By Arthur R. Colwell, M.D. 8°, cloth, 350 pp., with 24 illustrations. Chicago: The Year Book Publishers, Incorporated, 1947. $5.25.

Dr. Colwell is such an outstanding investigator and physician that his book on diabetes mellitus is sure of a welcome. Although not conventional, it is certainly provocative that he omits the word pancreas in the first paragraph, captioned "Definition," of the first chapter. All doubt, however, of the writer's belief in the unity of diabetes is dispelled in the pages that follow. Interestingly, he brings out the connection between the anterior pituitary body, the suprarenal glands and the thyroid gland and shows that in the presence of hyperfunction of these ductless glands hyperglycemia and glycosuria are apt to occur. For practical purposes he concedes that diabetes mellitus is a relative insulin deficiency except when specific pituitary, adrenal, thyroid or sympathetic overactivity can be demonstrated and removed.

The reviewer is sure that Dr. Colwell did not fully consider the implications of another sentence in that first paragraph, which reads as follows: "The anomaly of glucose metabolism with ketosis is subject to control by diet and insulin but the course of the disorder and its arteriosclerotic complications are not influenced to any major degree." But the reader can be assured that the author does enthusiastically believe in the active treatment of the disease and that he points out these results in the retardation of its progress. He emphasizes the desirability of prophylaxis and treatment in the prediabetic stage. This is brought out in his discussion of heredity, in which he cites the anticipation of diabetes in succeeding generations, quoting the work of Woodyatt and Spetz, and notes the possibility that diabetes will eventually work itself out. He enlarges on this point by describing the rate of progress, rapid in youth and slow in advancing years of diabetes, and then suggests that if these slants are extended backward they converge at the approximate time of birth, indicating that the diabetes of a predetermined type is inherited. He goes so far as to suggest that its course is approximately half run by the time it is recognized clinically. Whether diabetes will work itself out in the fourth or fifth generation will soon be known. There are so many diabetic children now who have grown up and married that it will not be long before it can be determined whether the incidence of diabetes in their offspring, the presumable fourth and fifth generations, is actually greater than that in the second and third. Before drawing conclusions, however, one must remember that only one in 25,000 persons under fifteen years of age was found to be diabetic by the National Health Survey.

All interested in diabetes will regard as important the following statements:

> Diabetes at the stage, before glycosuria is persistent and harm has occurred, is easily treated and its progress prevented or delayed. It is important to recognize it early and treat it meticulously. Temporary improvement could become permanent, as indicated by animal experimentation, if mild diabetes were taken as seriously as severe diabetes and if the idea of protection from permanent islet damage were entertained. . . . Much diabetes which could be kept innocuous by consistently good control is permitted to become severe because of complacency in regarding the lack of associated symptoms and ease of desugarizing.

The blame for this complacency the author puts largely on the medical profession. By control of diabetes he means control of the hyperglycemia. He is convinced that one should first get the patient sugar free and then increase the carbohydrate slowly as advocated generally by the best European clinicians of a former generation.

The description of the various insulins is excellent, and physicians are indebted to Dr. Colwell for details of their manipulations, especially for the description of his own method of mixing two parts of quick insulin with one part of protamine zinc insulin in one syringe. The reviewer agrees with his preference for a syringe of 1-cc. capacity divided in tenths. The details of the technic of administering insulin are excellent.

The section on acidosis (forty-three pages) is seriously written but prolix. One wishes the author had seen fit to insert in two or three pages a summary of H. F. Root's version of treatment of diabetic coma, which has been approvingly recognized by R. H. Micks in a study entitled "Diabetic Coma" (*Brit. M. J.* **2**:200-203, 1948). There is always a reason for a writer's adherence to certain methods. This is disclosed by hints here and there that he has so often waited long for laboratory reports that he has tried to build up a safe method of treatment without them. The reviewer is positive that if Dr. Colwell had been afforded reports of blood sugar and carbon dioxide tests within thirty or forty minutes after request, his treatment of diabetic coma would have been entirely different. It is regrettable that his results of treatment are not presented. Potassium is not mentioned although the fish-mouth syndrome might well have occurred in some of his cases since deficiency of potassium is almost exclusively confined to patients treated with injections of glucose or enormous quantities of liquids.

Issue at once must be taken with the following statement upon arteriosclerosis:

> It is generally true that the most severe diabetes is not uniformly associated with vascular disease. There is no constance in the relationship between the severity of the disorder of sugar metabolism and vascular disease; indeed if anything, the reverse seems to be true.

All grades of arteriosclerosis occur in the young as well as in the old, varying with the duration and control of the diabetes. It is not strange that the smaller blood vessels are as notably affected in the young as in the old, although for the early manifestations of the arteriosclerotic process in youth one looks most commonly for calcification demonstrable by x-ray examination in the vessels about the ankles, the lower legs and the pelvic arteries. Indeed, the calcification of the pelvic arteries in young female patients with diabetes is one of the best prognostic indications of whether the patient will have a living child. The relative clinical absence of gangrene, cerebral and myocardial lesions of vascular origin in the young is largely due to the malignancy of the vascular disease in the kidneys prematurely shortening life, as is shown at autopsy.

It is regrettable that transmetatarsal amputations, described by McKittrick several years ago and carried out on a large scale, are not even mentioned, because this operation often results in the prevention of an amputation of the thigh. Similarly, it is surprising that after amputation it is advised that the stump should be left open. Nearly a generation ago this practice, at least in this vicinity, was ended by Dr. Daniel Fiske Jones. Under no circumstances can one subscribe to the efficacy of penicillin ointment, which in the war proved to be less effective even than Dakin's solution. One would also decry the following statement: "The procedure of greatest value is the use of continuous warm moist compresses of generous thickness which is kept warm with an automatic heat cradle and not permitted to dry out." Warmth in the treatment of active infection we thought belonged to a former era and was even as outmoded as soaking a foot. As a matter of fact, no local surgeons have been heard to recommend soaking of an extremity in any kind of liquid during the last twenty years. In the discussion of carbuncles Dr. Colwell suggests that the best available method of treatment is radical incision. Years ago that was true, but since the advent of the sulfonamides and penicillin the carbuncles disappear like dew before the sun, and operation upon a carbuncle is a rarity.

Again, the reviewer cannot subscribe to the idea that "the treatment of diabetic polyneuritis is just about as ineffective as anything in the entire field of medicine." It is granted that treatment is not spectacular in days or weeks, but it is spectacular in months and so remarkable that patients who have been cured are always available, even though they live at a distance, to come to the hospital to cheer a sufferer in the active stage. Moreover, one should combat the idea that the symptoms of neuritis flare up with the beginning of treatment. Careful questioning practically always elicits the presence of these symptoms long before, although they may have been in the background, because of the more intense symptoms associated with the nonutilization of glucose, the "polys," pruritus and loss of weight and strength.

Fat atrophy is very common. The reviewer cannot agree that it "usually is permanent and harmless," because in his experience, especially in children, fat atrophy is temporary.

This book is strongly recommended despite the few criticisms mentioned. It is truly provocative and stimulating. The reviewer knows that he has profited greatly by the hours spent in its perusal and that his own patients will benefit thereby, particularly because of the author's insistence upon very early and aggressive treatment of the disease and the hope thus awakened for its control and the prevention of disturbing complications.

## BOOKS RECEIVED

**The receipt of the following books is acknowledged, and this listing must be regarded as a sufficient return for the courtesy of the sender. Books that appear to be of particular interest will be reviewed as space permits. Additional information in regard to all listed books will be gladly furnished on request.**

*Medical Research in War.* Report of the Medical Research Council for the years 1939-45. Committee of Privy Council for Medical Research. Presented by the Lord President of the Council to Parliament by Command of His Majesty, December, 1947. 8°, paper, 455 pp. London: His Majesty's Stationery Office, 1948. 7s. 6d.

This important document summarizes the research work done by the various divisions of the Medical Research Council. Of particular interest are the reports on wounds and injuries, war diseases, penicillin and nutrition. A list of selected references is appended to each subject. The text is well printed on good paper. The monograph should be in all medical libraries.

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*Diseases of the Chest: Described for students and practitioners.* By Robert Coope, M.D., B.Sc., F.R.C.P., consulting physician, King Edward VII Sanatorium, Midhurst, physician, Liverpool and North-Western Chest Surgical (E.M.S.) Unit, visiting physician, Maghull Epileptic Homes, lecturer in clinical medicine, lecturer in applied physiology and lecturer in clinical chemistry, University of Liverpool, and examiner in medicine in the university of Liverpool, London and Aberdeen. With a foreword by Lord Horder. Second edition. 8°, cloth, 541 pp., with 134 illustrations and 34 color plates. Baltimore: The Williams and Wilkins Company, 1948. $7.50.

This second edition of a book first published in 1944 has been revised to the extent of correcting certain errors in the description of the anatomy of the bronchial tree. The book was printed in Great Britain and bound in the United States. The type and paper are good, and the color plates are excellent. The volume should prove useful to those interested in the subject.

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*Human Neuroanatomy.* By Oliver S. Strong and Adolph Elwyn, associate professor of neuroanatomy, College of Physicians and Surgeons, Columbia University. Second edition. 4°, cloth, 442 pp., 336 illustrations. Baltimore: The Williams and Wilkins Company, 1948. $6.00.

The text of this new edition of a work, first published in 1943, and reprinted three times, has been revised, but not materially changed. A chapter has been added on segmental peripheral innervations, including a clinicoanatomic survey of the cervical, brachial and lumbosacral plexuses and of the main peripheral nerves. The chapter on the blood supply of the brain has been expanded to give a more complete and fully illustrated account of the arterial supply and venous drainage of the brain. The text is well printed, with a good type in two columns. A selected bibliography is appended. A good index concludes the volume. The book is recommended for all medical libraries and to all surgeons interested in the subject.

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*The Hospital Care of Neurosurgical Patients.* By Wallace B. Hamby, M.D., professor of neurology and neurologic surgery, University of Buffalo School of Medicine. Second edition. 8°, cloth, 156 pp., with 30 illustrations. Springfield, Illinois: Charles C Thomas, 1948. $3.00.

The second edition of this manual written for nurses and for young physicians has been revised and simplified at the suggestion of its readers. The volume is not intended as a treatise on therapy, which varies greatly in different clinics. A chapter on the relations of house officers has been added to the text.

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*Estudios sobre la Coca y la Cocaína en el Perú.* By Carlos Gutierrez-Noriega, M.D., and Vicente Zapata Ortiz, M.D. 8°, paper, 144 pp., with 32 illustrations, 8 tables, and 2 plates. Lima: Ministerior de Educación Pública, 1947.

The preliminary chapters of this monograph deal with the history and habitation of the cocoa plant in Peru. The following chapters, based on experimental work, treat of the physiology, the effects on the nervous system, mental activity and metabolism, and the action on muscular work, resistance to fatigue and toxicity of coca and cocaine.

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*The Baby's First Two Years.* By Richard M. Smith, M.D., Sc.D. 12°, cloth, 180 pp., with 15 illustrations. Boston: Houghton Mifflin Company, 1948. $2.75.

This new edition of a popular manual has been rewritten completely in many sections to conform with recent knowledge concerning the care of infants. The necessity for a fifth edition speaks well for the soundness of the manual, which should prove useful to mothers and others having the care of young children.

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*Coronary Heart Disease.* By A. Carlton Ernstene, M.D., chief of the section on cardiovascular disease, Cleveland Clinic, Cleveland, Ohio. 8°, cloth, 95 pp. Springfield, Illinois: Charles C Thomas, 1948. $2.50.

This short monograph is simply written, and the material is well arranged. It discusses coronary-artery disease in its various aspects, including angina pectoris, acute myocardial infarction, acute coronary failure, paroxysmal cardiac dyspnea, heart block, disturbances of cardiac rhythm and congestive heart failure. A short chapter on the risk of anesthesia and surgical operations in patients with coronary-artery diseases concludes the text. A selected bibliography and a good index conclude the volume. The text is well printed on good paper and should prove valuable to the practicing physician.

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*Physiologic Therapy in Respiratory Diseases.* By Alvan L. Barach, M.D., associate professor of clinical medicine, Columbia University College of Physicians and Surgeons, and assistant attending physician, Presbyterian Hospital, New York City. Second edition. 8°, cloth, 408 pp., with 74 illustrations. Philadelphia: J. B. Lippincott Company, 1948, $9.00.

The first edition of this book was published in 1944 under the title, *Principles and Practices of Inhalation Therapy.* This new edition includes much new material on other measures than the therapeutic use of gases for counteracting the clinical disorders of breathing. The author defines the term physiologic therapy as treatment designed to restore adequate function to organs impaired by disease. Special emphasis is placed on pathologic physiology. The type and printing are excellent, but the few illustrations do not justify the use of a heavy coated paper. The volume is recommended for all medical libraries and to all physicians interested in the subject.

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## NOTICES

### ANNOUNCEMENT

Dr. Field C. Leonard announces the opening of his office at 412 Beacon Street, Boston, for the practice of general surgery in association with Dr. Hollis L. Albright.

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### BOSTON SOCIETY OF PSYCHIATRY AND NEUROLOGY

A meeting of the Boston Society of Psychiatry and Neurology will be held at the Boston Medical Library, 8 Fenway, on Wednesday, December 15, at 8:15 p.m.

PROGRAM

Topectomy in the Treatment of Psychoses. Dr. J. Lawrence Pool (thirty minutes).

Relief of Intractable Pain by Unilateral Frontal Leukotomy. Dr. John E. Scarff (thirty minutes).

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### MASSACHUSETTS TRUDEAU SOCIETY

A meeting of the Massachusetts Trudeau Society will be held in the amphitheater of the Peter Bent Brigham Hospital on Wednesday, December 15, at 8:15 p.m. Dr. René J. Dubos, of the Rockefeller Institute for Medical Research, will speak on the subject "Bacteriologic Aspects of Tuberculosis."

Physicians and medical students are invited to attend.

(*Notices concluded on page xiii*)